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CARCINOMA IN AND AROUND THE HEAD OF THE PANCREAS

Report of Four Cases

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WHILE there is still some doubt about the value of radical resection for carcinoma of the pancreas, there is little doubt about the value of pancreatoduodenectomy for carcinoma of the ampulla of Vater, carcinoma of the distal or pancreatic portion of the common duct, and carcinoma of the duodenum. Considered separately, these last three types of carcinoma form a small per cent, but together they represent a sizable percentage.

Carcinoma of the ampulla offers the best chance for a cure because it usually grows locally and metastasizes late.[4] Radical resection of the head of the pancreas and duodenum is the only operation which offers a chance of cure for any of these types of carcinoma. Local excision is rarely curative. As experience is gained, the operation developed by Whipple becomes a reasonable and adequate procedure. Many factors have added to the safety of the one stage operation, but the use of vitamin K, a generous supply of whole blood, careful dissection and a good anesthetist are the most important. We rarely employ a two stage procedure because of the uncertain delay between stages and the technical difficulties encountered at the second stage.[5]

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Diagnosis

As Child[2] stated, early exploration should be performed in all cases of obstructive jaundice and in all cases of jaundice in which there is reasonable doubt between obstructive and hepatocellular disease. Pain is a common and often early symptom of carcinoma of the pancreas. It is constant and gnawing in character, frequently radiates to the back and occurs in more than half of the cases. Loss of weight, usually 8 to 12 pounds, occurs in practically all of the cases and it may be an early symptom when the tumor obstructs the main pancreatic duct. For the same reason, the loss of pancreatic enzymes, or digestive ferments, may cause early digestive disturbances and diarrhea.

In contrast to that associated with carcinoma of the head of the pancreas, the jaundice in carcinoma of the ampulla is less intense and frequently intermittent. The pain occurs in episodes and is often associated with vomiting, chills, fever and increased jaundice. Following an attack, the urine may be dark, but clears up in three or four days. Daily observation of the patient and consideration of the clinical findings may make it possible to distinguish between carcinoma of the head of the pancreas and of the ampulla. Symptoms vary greatly, especially digestive disturbances, depending on whether or not the pancreatic duct is obstructed. It is noteworthy that 1 of the patients in our series, with carcinoma of the pancreatic or distal portion of the common duct, felt well and had no digestive disturbance. His appetite was good, and there was no loss of weight, but the icterus index was over 200. Examination of the head of the pancreas removed at operation showed the common duct completely obstructed, but there was no obstruction whatsoever to the pancreatic duct.

More than half of the patients with carcinoma of the head of the pancreas or ampulla have a palpable distended gallbladder and about two thirds have an enlarged non-tender liver. Ulceration of the stomach and duodenum may simulate bleeding peptic ulcer in both carcinoma of the pancreas and of the ampulla. Massive hemorrhage may also occur.

Diagnosis at the operating table is often difficult. Obtaining a satisfactory specimen for biopsy is difficult and may be hazardous. Kirtland[3] advised the use of the Silverman needle. A pathologic examination giving negative results does not rule out carcinoma. We believe that if the history, clinical data and findings at operation are carefully considered and correlated, few mistakes will be made. The recent report by Mikal and Campbell[4] of 100 cases of carcinoma of the pancreas and 8 cases of carcinoma of the papilla

of Vater consecutively autopsied at the Boston City Hospital is of great help to the surgeon at the operating table. They stated that dilatation of the common bile duct is a more accurate indicator of Courvoisier's law than a dilated gallbladder. In 74 per cent of the cases of carcinoma of the head of the pancreas the gallbladder was distended, while in 86.6 per cent the common duct was dilated. The fact that in 42 per cent of the cases the gallbladder was chronically thickened and inflamed, with 20 per cent of the gallbladders containing stones, helps to explain these findings. Because of frequency of cholecystitis, these authors questioned the advisability of using the gallbladder for anastomosis in radical resection of the pancreas. Cattell and Warren[1] believed that dilatation of the duct of Wirsung, which may be palpated and aspirated, is one of the most reliable signs of carcinoma of the pancreas or ampulla. Mikal and Campbell[4] noted in the autopsies performed in their series that pancreatitis was present in 49 per cent of the cases of carcinoma of the pancreas. Intrapancreatic fat necrosis was present in 23 per cent, and there were pancreatic cysts in 15 per cent. These findings present another difficulty which would be encountered in obtaining a specimen for biopsy.

Four cases are reported as representing examples of carcinoma encountered in about the head of the pancreas and demonstrating problems in diagnosis which may arise before and during operation: 1 carcinoma of the head of the pancreas, 1 carcinoma of the ampulla, 1 carcinoma of the distal or pancreatic portion of the common duct, and 1 abscess of the head of the pancreas.

Report of Cases

Case 1. A 45 year old white man was admitted to the hospital on April 4, 1948. He was deeply jaundiced and he had noticed that his stools were light and his urine dark for the past four months. He had lost about 30 pounds in weight. He further stated that he had had intermittent episodes of epigastric distress with intolerance for fatty foods and nausea for the past six years.

On physical examination, the liver was enlarged about 8 cm. below the costal margin, and the gallbladder was palpable. Slight tenderness was present. The icterus index was 100. There was no urobilinogen in the urine on two occasions, and the stool gave no evidence of bile on four occasions. The result of the cephalin flocculation test was negative for 24 hours and 1 plus for 48 hours. A roentgenologic study of the gastrointestinal tract showed nothing abnormal.

On April 21, a pancreatoduodenectomy was performed, and a round hard mass about 4 cm. in diameter was felt in the head of the pancreas. The gallbladder and the common duct were distended. There was no metastasis to the liver. The pathologic report on the specimen removed was adenocarcinoma of the pancreatic ducts. All nodes removed were normal.

The patient made a good recovery from the operation, but returned to the hospital five months later complaining of pain radiating to the left upper quadrant of the abdomen and diarrhea. Four thousand cc. of ascitic fluid was aspirated from the abdomen. He returned home and expired on November 18. No autopsy was obtained, but it was believed that he died from general metastasis.

CASE 2. A 64 year old white man was admitted to the hospital on June 3, 1947 with painless jaundice of five weeks' duration. The urine was dark, and the stools were light-colored. He felt well with the exception of some slight fullness in the epigastric area. He had no pain and practically no digestive disturbance. His appetite was good, and he had noticed no loss of weight.

He was deeply jaundiced. A distended gallbladder and enlarged, non-tender liver could be felt below the costal arch. Reaction to the Van den Bergh test was 14 mg. direct on June 4 and again on June 7. The cholesterol was 614 mg. per 100 cc. on June 4, and examination of the stool for bile gave negative results. The prothrombin time on June 6 was 55 seconds compared to a control of 50 seconds. A survey roentgenogram of the abdomen showed the liver was enlarged.

It was thought that the palpable distended gallbladder made the diagnosis of obstructive jaundice certain. The abdomen was explored eight days after the patient was admitted to the hospital. A pancreatoduodenectomy was performed, and a cholecystostomy was done at the same time to relieve the pressure on the anastomosis of the common duct to the jejunum. Pathologic examination showed a grade II adenocarcinoma of the pancreatic or distal portion of the common duct. The duct of Wirsung was not obstructed. It was concluded that this fact accounted for the lack of digestive disturbance, the good appetite and no loss of weight.

The patient made an uneventful recovery and was discharged from the hospital 12 days following the operation. He returned to his occupation of farming within a month's time and was able to carry on his usual duties including plowing. He had no digestive disturbances and no pancreatin was required. He was able to eat almost anything.

About two years later, he was readmitted to the hospital because of soreness in the right upper quadrant of the abdomen with some pain and digestive disturbance. Metastases to the liver were present, and he was discharged shortly after admission. He died on May 24, 1949.

CASE 3. A 40 year old white woman first consulted us in the office on Feb. 7, 1950. She complained of frequent attacks of severe pain in the right upper quadrant of the abdomen, which radiated to the back. She had had some diarrhea and had lost about 10 pounds in weight, but had experienced practically no digestive disturbance. The onset of the present illness had occurred about two months previously, characterized by fever, chills and severe pain. She had been treated by a physician in her home. A fairly recent roentgenogram was suggestive of a growth pressing on the gallbladder. Pyelograms were normal.

Physical examination showed a rather slender woman of stated age. The skin and scleras had a slight ictiric tinge. There was a tender mass in the right upper quadrant of the abdomen which did not move on respiration. The liver did not appear to be enlarged. Laboratory work, which consisted of complete

blood count, prothrombin time, quantitative Van den Bergh test, cephalin flocculation, serum protein and albumin-globulin ratio, gave normal results.

On March 3, an exploratory operation was performed, and a firm mass was felt in the head of the pancreas. The remaining portion of the pancreas did not appear to be enlarged. Because of the stony hardness of the mass, removal of the head of the pancreas and the duodenum was decided upon. It was necessary to cut the common duct where the cystic duct joined it. For this reason, the gallbladder was removed. A complete pancreatoduodenectomy was performed. When the gross specimen was cut, it was found to be a thick-walled abscess with about a drachm of pus in the center. The pathologic diagnosis was pancreatitis with abscess formation.

It was thought at the time that the operation performed was not necessary. Possibly the patient was benefited somewhat by removal of the abscess. For the past two years she has been in good health and has suffered no ill effects. Small doses of pancreatin have been prescribed for occasional indigestion. Probably if more attention had been given to the history and the mass in the head of the pancreas had been aspirated, a radical operation would not have been performed. It is doubtful if this conclusion could have been reached at the operating table by attempting a biopsy section. It has been pointed out that in about 23 per cent of cases of carcinoma of the pancreas gross pancreatitis and fat necrosis are present. While such mistakes occur from time to time, they should be rare as experience is gained.

CASE 4. A 48 year old white woman was admitted to the hospital complaining of pain, indigestion, jaundice and itching. The onset of the present illness had occurred three weeks previously with nausea, vomiting, chills, fever and diarrhea. During the next two weeks, she had experienced several episodes of pain, nausea and vomiting. Following these attacks, the jaundice had become more intense, but had shown a tendency to subside in a few days. She had noted from daily observation of the urine that it was dark following attacks, but cleared up in three or four days. She complained of weakness and the loss of about 8 pounds in four weeks.

The pain was localized in the right upper quadrant of the abdomen, and there was tenderness in this area. The gallbladder could not be felt, but the liver was enlarged. The reaction to the test for urobilinogen in the urine was negative on two occasions and positive on one occasion. The prothrombin time was 44 seconds compared to a control of 32 seconds. The icterus index was 50 units on June 25, 75 on June 29, 82 on June 30, 76 on July 9 and 64 on July 12. The results of the Van den Bergh test were, direct, 6 mg. per 100 cc. on June 25, 4 mg. on June 29, 4 mg. on June 30, 8 mg. on July 6, 6 mg. on July 9 and 5 mg. on July 12. The results of the alkaline phosphatase test were 14 Bodansky units on one occasion and 18.4 on another occasion.

A diagnosis of obstructive jaundice, most probably of the ampulla of Vater, was made before operation. On July 16, 1951, a pancreatoduodenectomy was performed. At operation, the gallbladder and common duct were distended, and a firm mass about 1.5 cm. in diameter was felt in the region of the ampulla of Vater. The mass extended into the head of the pancreas; so local excision was not considered. There was no evidence of metastases to lymph nodes or the liver. The pathologic diagnosis was a grade II infiltrating adenocarcinoma of the ampulla of Vater with extension to the duodenum.

The patient made an uneventful recovery and was discharged from the

hospital twelve days postoperatively. She has been in good health since the operation. On one occasion, she had some vague digestive disturbance which cleared up with 15 grains of pancreatin three times a day.

Discussion

Analysis by Mikal and Campbell[4] of their large series of 100 cases of carcinoma of the head of the pancreas and 8 cases of carcinoma of the papilla of Vater consecutively autopsied is most enlightening. They stated: "Eighteen of the patients with pancreatic carcinoma and 6 of those with carcinoma of the papilla of Vater were considered operable at autopsy." Evidently a good many opportunities are being missed. It is well to emphasize again the advisability of more exploratory operations in cases of obstructive jaundice. Only in recent years has the satisfactory operation for carcinoma of the ampulla and distal portion of the common duct been developed. Most of the five year cures reported are in this group.

The radical operation for carcinoma of the pancreas itself should not be abandoned. The present poor results obtained in radical operations for carcinoma of the pancreas and the low rate of resectability may be compared to the results and low rate of resectability which existed when the operation of carcinoma of the stomach was first developed. Earlier diagnosis and improvements in technic should do much toward improving these conditions.

Conclusion

The operation of pancreatoduodenectomy is often curative for carcinoma of the ampulla and distal portion of the common duct. It is also compatible with good health. The mortality rate is steadily being lowered. Time and earlier diagnosis should do much to improve the results obtained from this operation. It is the only operation which offers the patient a chance for a cure.

REFERENCES

1. Cattell, R. B., and Warren, K. W.: Pancreatic surgery, New England J. Med. *244:*975 (June 28) 1951.
2. Child, C. G., III: Advances in Management of Pancreaticoduodenal Cancers, in Advances in Surgery, New York, Interscience Publishers, Inc. *2:*495, 1949.
3. Kirtland, H. B., Jr.: Safe method of pancreatic biopsy, preliminary report, Am. J. Surg. *82:*451 (Oct.) 1951.
4. Mikal, S., and Campbell, A. J. A.: Carcinoma of pancreas, diagnostic and operative criteria based on 100 consecutive autopsies, Surgery *28:*963 (Dec.) 1950.
5. Waugh, J. M., and Clagett, O. T.: Resection of duodenum and head of pancreas for carcinoma: analysis of 30 cases, Surgery *20:*224 (Aug.) 1946.

TRAUMATIC AVULSION OF BOTH ARMS, RIGHT CLAVICLE, SCAPULA, BREAST AND PECTORAL MUSCLES AND MULTIPLE RIB FRACTURES WITH OPEN PNEUMOTHORAX

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BECAUSE patients with such severe injuries rarely live, and because this patient exemplifies several other unique features, we believe the following case is of general interest and should be reported in the literature. This accident occurred close to a modern hospital where adequate therapy could be applied immediately. We believe this was responsible for her survival.

CASE REPORT

Mrs. C. H. C., age 47, widow, mother of four, was employed as a splicer on a bias machine in a Memphis factory.

On Jan. 27, 1950, while feeding the end of a new roll of stock into a rotary bias machine, the machine was inadvertently started, causing the roll of material to pull her violently into the high speed rollers of the machine inducing the following injuries:

1. Severe shock and extensive blood loss.
2. Complete avulsion of right arm, clavicle, shoulder girdle muscles, scapula and mammary gland.
3. Multiple compound fractures of the first through the tenth ribs on the right side; tearing through the pleura anteriorly (virtually ripping the right thoracic cage open in the anterior plane). Lung tissue protruded through the open chest wound.
4. Compound, comminuted, fracture of the left humerus with avulsion of the brachial plexus, brachial artery and vein, and muscles of the upper arm. There were multiple contusions and abrasions elsewhere on her body. Some subcutaneous emphysema was present in the neck.

Morphine sulphate, grains ¼, was given subcutaneously by the plant nurse while the patient was still caught in the machine. It took a crew of mechanics five or six minutes to extricate her from the machine. After removal, she was rushed to the Baptist Memorial Hospital, Memphis, Tennessee, less than one hour after the accident occurred.

On admission to the emergency room plasma was started through a No. 17 gauge needle in the right femoral vein and allowed to run as rapidly as the patient's circulatory system would absorb it, while blood was being typed.

The skin was cold, clammy, pale and cyanotic. The mucous membranes were almost white. Her blood pressure and pulse could not be obtained, but

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she was conscious and apparently in no pain. The right arm was completely cut off and the left arm was dangling by a few small shreds of skin and fascia a few inches from the humeroscapular articulation. The abdomen was soft with no tenderness. There was no bleeding from the right shoulder girdle stump and very little bleeding from the left arm. There was a wide open sucking wound of the right chest about 3 inches wide which extended from the clavicle to the tenth rib leaving the lung and diaphragm exposed. One could look directly into the right thorax and see cardiac pulsations, which were very rapid and weak; and the pendulum-like swing of the mediastinum with each respiration. The patient was still conscious and responded to questions.

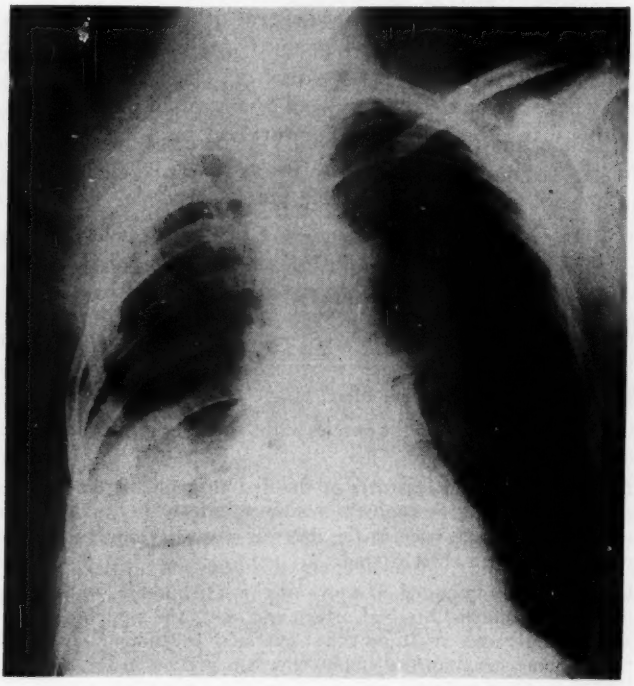

Fig. 1. Chest roentgenogram made six days after the patient's accident. The fractured ribs on the right (ribs number 1 through 10), the right pleural reaction and minimal pleural effusion, and the contracted right hemithorax are well seen. Note the absence of the right scapula and clavicle.

Dr. Ray Stark, chief anesthesist at the Baptist Hospital, was summoned to administer oxygen and anesthesia. Abdominal pads were placed over the opening in the right thorax and held manually; stacking the pads on until the wound stopped sucking with each respiration. This in turn eliminated the shock from the mediastinal swing. Only a very few minor bleeding points had to be controlled at this time. The major vessels that had been torn were not bleeding, due to a combination of very marked angiospasm plus clotting in the open ends of the vessels. After 1,250 cc. of plasma had been given, blood had

been matched and was substituted through the same No. 17 gauge needle in the right femoral vein. This was allowed to run as rapidly as possible. There was no appreciable improvement in the patient's condition after approximately 45 minutes. The pulse was too rapid and weak to count; no blood pressure was obtainable, and respirations continued to be very rapid and shallow at 36 to 50 per minute. It was thought that further procrastination would not improve a seemingly hopeless condition. We decided to operate, although obvious shock was still present; in order to restore the chest to a more physiologic condition.

Operation

With an endotracheal tube in place and giving only a minimum amount of ether, the skin surface around the wound was washed with soap and water and prepared with ether and merthiolate, and then draped with sterile towels and sheets. The open thoracic cage was irrigated with saline solution. Careful inspection revealed no tears in the mediastinum, pericardium or diaphragm.

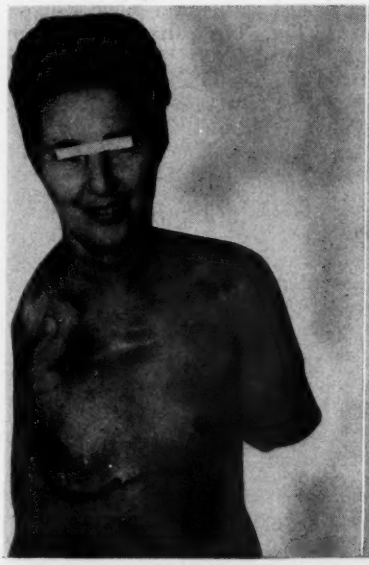

Fig. 2. This picture was made approximately two months following the accident. There is still some necrosis just below the right nipple involving only the skin.

Fig. 3. Back view showing the marked narrowing of the right hemithorax and complete loss of the right shoulder girdle and arm.

The torn skin margins and all devitalized tissues over the right chest wound were debrided, and several sharp rib fragments were removed. Several large blood clots were removed from the pleural space. The space was then thoroughly irrigated with saline solution. This was then aspirated. The chest wall was closed in layers using interrupted sutures of No. 30 cotton throughout. The upper 10 ribs on the right side were fractured, some in two or three places. Closure of the bony cage was not entirely air-tight.

Despite loss of some of the ribs and pleura it was possible to close the remaining ribs and pleura in all but a few small areas. This was possible because fractures of the ribs posteriorly made the thoracic cage fairly pliable. The areas in the pleura which could not be closed were covered with subcutaneous tissues to make the chest air-tight. The injury left no muscles over the right thoracic cage so the next step was closing the skin. There was enough skin to obtain an air-tight closure over all the raw surface, although there was some tension at the mid-portion of the incision. Four large tension sutures of No. 2 silk were placed at this point to reduce some of the tension on the suture line. The lung was re-expanded at the conclusion of this part of the operation.

After removal of necrotic and devitalized tissue the patient's condition began to improve. The pulse and respiration became slower, and her dark ashen color became a noticeable pink. As soon as possible a cut-down was done in the left ankle for easier intravenous fluid administration.

The right axillary artery and vein were doubly ligated with No. 30 cotton and the brachial plexus excised at the chest wall. After debridement of the arm wound on the left, the wound was irrigated with warm saline solution to remove loose particles of dirt, clothing, and lint. The axillary vessels were then ligated as on the right side and the brachial plexus excised. Sulfanilamide powder was dusted into the arm wound and the wound closed loosely with several sutures of No. 2 silk. No attempt was made to secure skin apposition because of the danger of infection. The left arm was fractured in numerous places and the vessels and nerves completely torn, making any thought of saving this arm hopeless.

The left arm amputation stump was closed by suturing the remnants of the biceps and triceps muscles together over the bone, then closing a posterior flap over the stump. The entire operative procedure required 2 hours and 10 minutes. The patient received 2,500 cc. of whole blood before, during, and after the operation, in addition to 1,250 cc. of plasma which was given in the emergency room. The patient was sent to her room with a canula in the left ankle vein for fluid administration, and a thoracotomy tube in the ninth intercostal space at the posterior axillary line, connected to a water-trap bottle. At this time a blood pressure of 120/86 was obtained in the thigh.

Postoperative Course

Postoperative orders were: nasal oxygen, 5 liters per minute; procaine penicillin, 600,000 units daily; streptomycin 1 Gm. twice daily; prophylactic tetanus antitoxin and a slow continuous intravenous drip of 5 per cent dextrose in water. No blood count was obtained before surgery but on the day following operation the red blood count was 3,800,000 erythrocytes with 11.5 Gm. of hemoglobin per 100 cc., and a hematocrit of 40 per cent. Urinalysis that same day showed a trace of albumin and a specific gravity of 1.023. Otherwise it was negative.

On Jan. 31, 1950 the blood count had risen to 4,710,000 erythrocytes with 15 Gm. of hemoglobin per 100 cc. The night following surgery 1,000 cc. of blood was given. The following day 500 cc. of blood was given in the morning and repeated in the evening. The next two days 500 cc. of blood was given each day.

For the first 48 hours there was considerable abdominal distention due to a paralytic ileus for which Wagensteen suction was used and Prostigmine was

given. The day following surgery she was vomiting and still had some abdominal distention and early atelectasis of the right upper lobe.

She raised gray, purulent sputum when she coughed. By turning her frequently and supporting her chest when she coughed the atelectasis cleared rapidly without bronchoscopy or tracheal suction.

Her left leg became edematous on the second postoperative day and it was thought at first she might have a femoral vein thrombosis. A previous hospital chart was studied which revealed that in June of 1948, the patient had pelvic surgery complicated by a left leg thrombophlebitis. We therefore assumed that the present edema was due to faulty circulation from this previous thrombophlebitis. Prophylactic ligation of the femoral veins was considered unnecessary because of the long duration since the thrombophlebitis. On the day following surgery it was noted that the right external jugular vein was completely thrombosed but not very tender. It caused no further difficulty.

No thoracentesis was necessary after the thoracotomy tube was removed, on the fourth day. On the sixth day a roentgenogram of the chest showed good aeration of the right lung with a small amount of fluid and pleural reaction

Fig. 4. Illustrates the suspension of her mechanical arm which is activated by the left shoulder muscle.

in the right base. By the eighth day the patient was sitting up in a chair for short intervals, and graduated exercises were continued from this stage. On the ninth day the patient complained of some nausea and vomiting, abdominal discomfort and a sore tongue. Examination revealed a red, swollen, slick tongue and other signs compatible with vitamin B deficiency. She was given ribroflavine and niacin and 8 ounces of a high protein formula orally between

meals and at bedtime. Hemopoetic capsules were also given, and these symptoms subsided readily. On the tenth day the sutures were removed from the right chest wound. Several small stitch abscesses were present. Skin grafting was therefore not considered advisable at this time. Her temperature rose to 103 F. rectally the day following surgery but slowly subsided. By the tenth postoperative day it was normal and remained so with only occasional elevation to 99 F. during the rest of her stay in the hospital. The antibiotics were discontinued on the fourteenth postoperative day. There was an area of skin approximately 2 inches in diameter just below the nipple area of the right chest that later sloughed. In order to approximate the skin at all, at the time of surgery, a considerable amount of subcutaneous tunneling had to be done to pull the skin edges together. Also, redness, tenderness and edema were noted in the left arm and stump. This was not relieved by hydro and physiotherapy. Twenty-five days after the accident the patient was taken back to the operating room and under light anesthesia the left amputation stump was opened. Several areas of liquified tissue surrounded by induration were found in the subcutaneous fat around the stump. The muscles appeared viable. The necrotic areas and the redundant skin of the stump were excised and the skin closed. The excess skin was used as a graft over the defect in the right anterior chest wall.

Fig. 5. Demonstrates one of her many skills.

From this time on the patient continued to improve. The marked difference in weight of her shoulder regions made it difficult for her to learn to keep her balance while walking. At the time of her discharge from the hospital, she was cheerful, intelligent, afebrile and ambulatory. Surprisingly, she never complained of much pain. She had complete amnesia for the first three days of her

illness and never seemed depressed over her accident. On May 31, the patient was flown to Boston, Mass., and there admitted to a rehabilitation center, run by the Liberty Mutual Insurance Company. This insurance agency carried the compensation insurance on the employees of the company where the patient worked at the time of the injury. She was placed on a rigid training program to increase motion in the left shoulder girdle muscles and to prepare the left amputation stump for prosthesis. A technical difficulty was encountered because of loss of the shoulder muscles on the right, which precluded activation of a prosthesis from the opposing side. However, eventually one was devised with a perineal strap and cross straps that allowed activation by controlled use of the shoulder muscles on the left side.

A never faltering determination to become independent on the part of the patient and an inestimable amount of understanding and patience on the part of the personnel of the rehabilitation center overcame all difficulties encountered and on Dec. 27, 1950, she returned to Memphis. On Jan. 15, 1951, less than one year from the date of the injury, she returned to work taking over a job and efficiently performing the duties that had been done by a normal individual. She can now write legibly; dial a telephone; hold a receiver to her ear; open doors; drink from a glass, china, or paper cup; feed herself easily with a fork or spoon; bathe herself; comb her hair and perform numerous other activities. By the use of special clothing she can dress herself. Control of her prosthesis is so delicate that she can pick up cigarette ashes without crushing them. Her job now is that of matron which requires checking supplies and overseeing several maids. This requires the equivalent of walking five or six miles daily; climbing up and down stairs; opening several doors and going through many departments in the factory where there is considerable activity and moving of equipment and personnel. She has performed her duties for 16 months and has missed only two days from work because of a severe cold. This includes a period during the winter when there was ice and snow on the ground. She has fallen a few times but with no ill effects.

Summary

Her recovery and rehabilitation were remarkable. The impression of all who saw her at first was that it was futile and a waste of time to try to do anything. We believe that the following points are important:

1. A remarkable determination on the part of the patient to get well and become a useful individual, plus the courage and tenacity to overcome seemingly unsurmountable difficulties.
2. No attempt to treat the patient's shock initially at the factory until adequate amounts of plasma and blood were available. This delay was sufficient for the large blood vessels to become firmly closed by blood clot, preventing further blood loss when fluids were started.
3. Plasma and whole blood; 1,250 cc. of plasma and 4,000 cc. of whole blood the first 24 hours.
4. Early closure of a huge open chest wound and thorough de-

bridement which prevented the absorption of toxic material from the devitalized tissues.

5. Although there was severe damage to the thoracic cage, the mediastinum and pericardium were uninjured.
6. Despite extensive and severe injury there were no major infections.
7. The absence of serious complications which are usually expected in extensive injuries.
8. Excellent postoperative care.
9. Excellent attention and training at the rehabilitation center and ingenuity in developing a functional prosthesis.
10. A large amount of that undefinable element called luck.

Addendum

On Dec. 12, 1951, the President of the United States presented a citation to this patient for outstanding service, through the medium of Representative Clifford Davis. Mrs. C. maintains her own home, where she lives with her 16 year old son, a high school student. The citation was headed "The President's Committee on National Employment of Physical Handicap Week in recognition of outstanding effort extended in promoting equal opportunity in employment for the physically handicapped."

STREPTOMYCIN IN THE TREATMENT OF DRAINING TUBERCULOUS SINUSES

Report of a Five-Year Follow-Up*

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TWELVE patients with draining tuberculous sinuses were treated with streptomycin in the latter half of 1946 at the Veterans Administration Hospital, Oteen, North Carolina. An early report of these cases was published in the Journal of the American Medical Association, Sept. 20, 1947, by Dr. Benjamin L. Brock.[1] Five years after their original course of treatment, all the living patients were re-examined. One patient had died two and one-half years after the first treatment course. The results of the follow-up study of this entire group are presented in this paper.

The group was made up of 11 Negro males and 1 white female. Sixty draining sinuses were present in the 12 patients at the time treatment with streptomycin was begun. These had been present for an average of 24 months before treatment. In all but 2 of the patients, they originated in bony lesions, roentgenographically demonstrable either at the time of treatment, or subsequently. In one of the 2 nonosseous cases, a sinus developed following appendectomy for tuberoulous appendicitis; in the other, several perineal sinuses originating in the ischiorectal area were present. Tuberculous etiology was proved by biopsy specimen or culture of the sinus material in all of the group. Six of the patients at one time also had pulmonary tuberculosis but in only 1 of these was the disease active at the time the sinuses were treated.

The original course of streptomycin consisted of 1.8 Gm. of the drug in six divided doses given by intramuscular injection daily for 90 days. Half of the patients received an additional 60 days of streptomycin following a three week interim, and 2 patients required still further courses later on.

The earlier report emphasized the striking improvement in the general condition of the patients so treated, with weight gain, increased appetite, and a sense of well-being, even in previously extremely emaciated patients who were considered to be in a critical condition. Febrile patients promptly became afebrile. Early closure

*Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are the results of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

of the sinuses (within two months after the administration of streptomycin was begun) was achieved in one-third of the patients. All but 1 of the remainder had healed within five months of the beginning of treatment.

Toxic reactions of headache, dizziness, and ataxia were observed regularly at this dosage of streptomycin but were of clinical significance over the years in only 1 patient. This 51-year-old colored man had a normal audiogram two months after completion of streptomycin treatment. A staggering gait and a positive Romberg's sign were noted, however, two years after the course of streptomycin. Two and a half years after treatment, he staggered and fell sustaining a laceration of the scalp which required suturing. He became delirious, according to a hospital report, during the next few days, and was admitted to another hospital where he was found to have some localizing neurologic signs, and 2000 red blood cells per cu. mm. of spinal fluid. He died the day after admission with a clinical diagnosis of cerebral vascular accident. No autopsy report was available. This patient's sinuses had healed following a single 90-day course of streptomycin, and they remained healed until the time of death two and one-half years later. This was the only death in the group.

Permanent closure of the sinuses was achieved in eight patients (67 per cent). Eleven of the patients also received some type of surgical treatment prior to, concomitant with, or subsequent to treatment with the antibiotic. The one exception had been immobilized in a body cast prior to treatment with streptomycin. Surgery consisted of incision and drainage of abscesses, curettement of necrotic bone lesions, resection of osteomyelitic foci, excisions of sinus tracts, or spinal fusion.

Two of the recurrences occurred two years after healing of the original sinuses had been achieved. One recurred after three years and the fourth after three and one-half years. Three of these patients received further surgical treatment and longer courses of streptomycin. One is currently hospitalized.

This was not apparent in 1 patient until four years after treatment of an anterior chest wall sinus.[2] Three of these patients underwent spinal fusion. One operation was done a year and a half before streptomycin treatment was begun, one three months after completion and the third four and one-half years after completion of chemotherapy. One of the patients with vertebral involvement was treated by immobilization in a body cast, and 3 had incision of cold abscesses, or resection of rib or cartilage with their streptomycin and bed rest. All the living patients with tuberculosis of the spine now have inactive vertebral lesions. One was recently hospitalized for

tuberculous sinuses for the extremities and face. Another has just completed rehabilitation one year following spinal fusion.

TABLE I

Results of Treatment

Type of Sinus	No. of Patients	Early Closure 5 Mo.	Late Recurrence	
			No.	Per Cent
Bone	10	9	4	40
Soft Tissue	2	2	0	0
Total	12	11	4	33

Seven patients had roentgenographic evidence of vertebral involvement.

TABLE II

Bones Involved in 10 Patients with Tuberculous Sinuses

Bones	Patients	Bones	Patients
Vertebrae	7	Skull	2
Tibia	4	Sternum	1
Ribs	3	Wrist	1
Ankle-Foot	2	Radius	1
Scapula-Clavicle	2	Pelvis	1
Fibula	2		

Evidence of regeneration of bone in "punched-out" areas of the shafts of long bones and vertebral bodies and in osteolytic foci of the cranial bones has been found. This has occurred over a period of many months, and has been complete in some lesions and fairly complete in others. The following 4 case reports illustrate this bone regeneration or healing:

Case Reports

Case 1. M. B., a Negro man aged 23, had a unilateral exophthalmos and roentgenographic evidence of advanced destruction of the orbital portion of the right frontal bone prior to streptomycin treatment. There were, in addition, six draining sinuses originating in the right clavicle, many ribs, the last thoracic and first lumbar vertebrae, and the wing of the left ilium. Extrapulmonary tuberculosis had been present for three years before treatment was begun, and his course had been progressively downhill. One and eight-tenths Gm. of the drug were given for 150 days beginning in July 1946. Marked clinical improvement was soon apparent and was accompanied by a weight gain of 20 pounds. The first sinus closed two months after treatment began; the orbital sinus closed in three months and the last sinus was closed 15 weeks

after treatment. Surgical treatment consisted of removal of necrotic bone from the orbital region and partial resection of the second rib on the left. A year after closure of his sinuses he was transferred to another Veterans

Fig. 1-a. M. B., Negro man age 23. Sept. 1, 1946, illustrates subclavicular chest wall sinus and exophthalmos of the right eye.

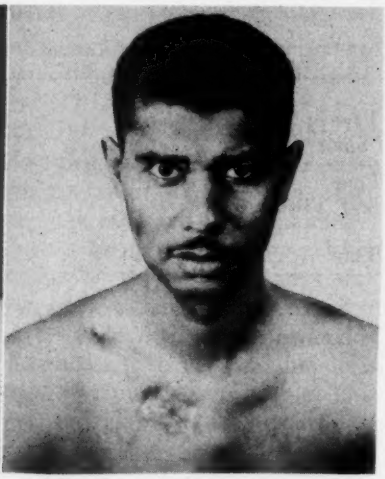

Fig. 1-b. Jan. 16, 1947, illustrates the subclavicular sinus and marked improvement of the exophthalmos of the right eye.

Administration Hospital for plastic surgery on the right eyelid. On re-check five years later all the sinuses had remained healed. Roentgenograms of the skull showed no evidence of active bony tuberculosis. Old healed tuberculosis with marked bridging between the bodies of the last thoracic and first lumbar vertebrae was evident. There was no evidence of tuberculosis involving the ribs.

CASE 2. E. S., a 24-year-old Negro man (fig. 2) had multiple draining tuberculous abscesses on his body and extremities for two years prior to streptomycin treatment. Twenty-three sinuses were draining pus from eleven bony foci of tuberculosis at the time administration of the antibiotic was begun in June 1946. There was no evidence of pulmonary tuberculosis. Ninety days treatment with streptomycin was given and by September all the sinuses were healed. One month after completion of the first course of streptomycin, however, a sinus low on the right anterior chest re-opened, and the patient was given an additional 60 days of streptomycin therapy. At the end of January 1947, the sinus and the right sixth costal cartilage were excised. All drainage had ceased six months later. For approximately two years, the patient's sinuses remained closed. In 1949 there was a recurrence of pain and swelling in the left leg, for which a course of 1.0 Gm. of Dihydrostreptomycin by intramuscular injection daily, and 12.0 Gm. of Para-aminosalicylic acid in three divided doses by mouth were given daily for 120 days. A right chest wall abscess occurred in October 1950 and, after incision and drainage, a fourth course of streptomycin was begun in May 1951. This was continued until the patient went absent without leave two weeks later. The sinus was

still draining at the time the patient left the hospital. When he was examined seven months later (Dec. 13, 1951), the sinus had been healed for one month. Roentgenograms showed regeneration of "punched-out" areas of destruction in both right and left cromion process, and an inactive lesion with sequestrum formation in the left tibia.

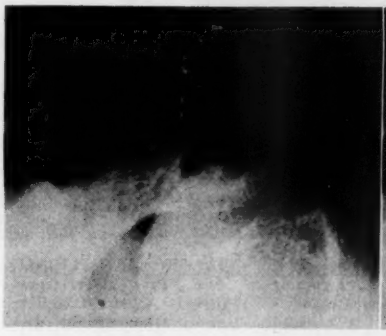

Fig. 2-a. E. S., Negro man age 24. June 18, 1946, abscess of the left acromion process before treatment.

Fig. 2-b. Dec. 28, 1949.

Fig. 2-c. Dec. 13, 1951, five years after treatment. Bony structure is restored.

CASE 3. C. M., a 21 year old Negro man (figs. 3 and 4). Active pulmonary tuberculosis was diagnosed in January 1945. A fluctuant abscess over the upper third of the right fibula was incised June 21, 1946. A positive culture for acid-fast bacilli was obtained. Roentgenologic examination revealed an osteolytic process of the right fibula. Tuberculosis was also present in the right pisiform bone and the right knee. There was erosion of the second to fifth cervical vertebrae and a destructive process of the third and fourth dorsal vertebrae. Five draining sinuses were present. Streptomycin therapy was initiated Sept. 23, 1946 and a body cast applied. The chemotherapy was continued for 90 days. All sinuses were closed in one month. Progressive improvement in the "punched-out" area of the right fibula is seen in figures 3 and 4 from the onset of the process on May 10, 1946 to its present healed

state Oct. 11, 1951. A thoracoplasty later controlled his pulmonary lesion. He now attends college and all sinuses are healed.

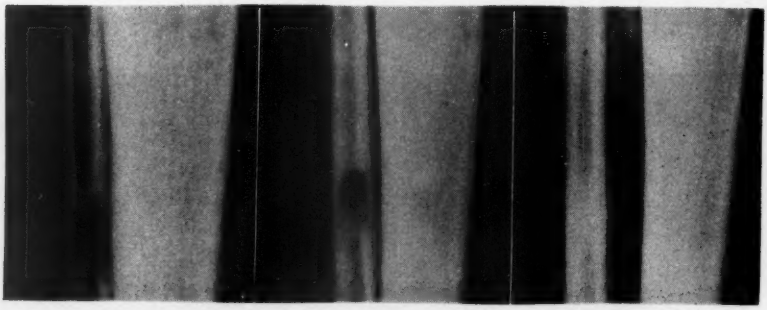

Fig. 3-a. C. M., Negro man age 21. Sept. 14, 1946, "punched-out" abscess of the right fibula before treatment with streptomycin.

Fig. 3-b. Jan. 14, 1947, one month after completion of treatment.

Fig. 3-c. Oct. 11, 1951, five years after treatment. Almost complete obliteration of the diseased area.

CASE 4. L. S., a 30-year-old Negro man, had an anterior chest wall sinus following incision and drainage of a chest wall abscess five months before treatment with streptomycin was begun in June 1946. There was no roent-

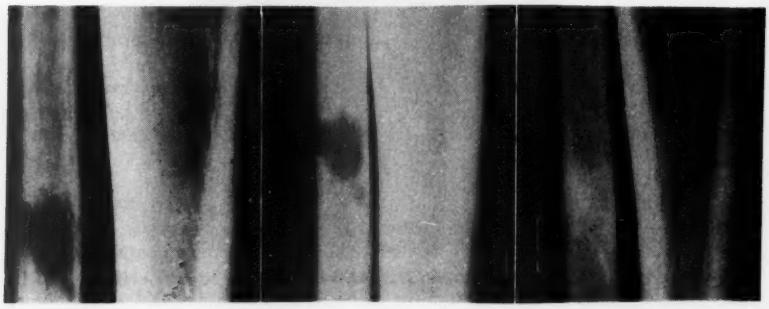

Fig. 4-a Fig. 4-b Fig. 4-c

Figs. a, b, and c, show lateral views of the right fibula on the same dates as in figure 3.

genographic evidence of bony tuberculosis at that time. A left pleural effusion had been present one year earlier. A right thoracotomy for post-pneumonic empyema had been done five years before treatment with streptomycin. The patient had a septic temperature when chemotherapy was begun but after a month of streptomycin (1.8 Gm. per day), the temperature became normal and cultures of material from the tuberculous sinus failed to grow tubercle bacilli. Healing of the sinus was complete in three months. This patient

received streptomycin for 150 days. He remained well until August 1949 when he returned to the hospital with a fluctuant mass in the lumbar area. Lumbar and psoas abscesses were drained in November and February. A destructive lesion between the bodies of the eleventh and twelfth dorsal vertebrae was ultimately discovered in July 1950. Spinal fusion was carried out two and a half months later. This resulted in arrest of the disease in the thoracic spine. The patient has recently completed rehabilitation and has been discharged from the hospital. He has no draining sinuses at present.

Discussion

The majority of recent reports emphasize the fact that streptomycin does not remove the need for adequate surgery when used in the treatment of tuberculous sinuses. It does make surgery possible earlier, and in cases where it otherwise could not have been employed. In the presence of inadequate drainage, or "of a sequestrum, a thick-walled abscess, an uncollapsed bony pocket, or inadequate stabilizing surgery of the infected joint" failure of healing may occur.[8] The use of streptomycin has made possible the abandonment of the old policy of avoiding drainage of cold abscesses.

Actual regeneration of bone destroyed by the tuberculous process was observed roentgenographically in 3 patients. This occurred in long bones, flat bones, and vertebral bodies. It indicates that the destructive lesions of bony tuberculosis may not always be irreversible.

Summary and Conclusions

Twelve patients with a total of sixty chronically draining tuberculous sinuses were treated with streptomycin five years ago, for 90 or 150 days. All but 2 of the patients had underlying bony tuberculosis. Surgery preceded, accompanied, or followed the course of streptomycin in all but 1 patient. The early results were excellent. Late recurrences occurred, however, in 4 patients (33 per cent). These patients required further treatment, and 1 is still in a hospital. Neither of the 2 patients with soft tissue tuberculous sinuses had late recurrences.

Evidence of bone regeneration in "punched-out" areas of bone destruction was found in 3 patients. There was one death in the series. This patient died of a cerebral vascular accident two and one-half years after treatment. All his sinuses were healed at the time of his death.

Streptomycin is a valuable aid in the treatment of tuberculous

sinuses, but it does not remove the need for adequate surgery. It does make possible the earlier employment of surgical therapy and the use of surgery in otherwise inoperable cases.

REFERENCES

1. Brock, B. L.: Streptomycin in treatment of draining tuberculous sinuses, J.A.M.A. *135:*147 (Sept. 20) 1947.
2. Bosworth, D. M.: Orthopedic problems in tuberculosis, Surg. Clin. N. America *31:*417 (April) 1950.
3. Bosworth, D. M., Della Pietra, A., and Farrell, R. F.: Streptomycin in tuberculous bone and joint lesions with mixed infection and sinuses, J. Bone & Joint Surg. *32-A:*103 (Jan.) 1950.

MASSIVE PERIPHERAL NERVE TUMOR

Report of an Unusual Case

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A case of neurofibrosarcoma is being reported only because it presented several unusual manifestations and difficulties, both clinically and diagnostically. We believe that these peculiarities warrant a single case report.

Case Report

A 63 year old white man was admitted to the hospital on Dec. 3, 1947, with a referring diagnosis of Raynaud's or Buerger's disease. The chief complaints were severe pain in and around the lateral malleolus of the left ankle, pain in the lateral side of the sole of the foot, and swelling of the left extremity from the knee to the tip of the toes. These symptoms had been present for approximately six months, and there was no previous history of injury to the affected extremity. The family and systemic reviews were noncontributory.

On physical examination, the patient was a well developed, well nourished, white man, who appeared to be rather pale. The teeth were carious and there was a slight increase in blood pressure. Other findings were within normal limits except the left lower extremity. The left lower extremity presented a pitting edema from the midthigh to the tip of the toes. The color was normal and the toes were warm. There were good dorsalis pedis and posterior tibial pulsations. One localized area in the calf of the leg posteriorly was exquisitely tender, and, according to the patient, this tenderness had progressed in severity. At the time of his first hospitalization all the laboratory work was within normal limits and roentgenograms of the involved extremity did not show any visible calcification of the vessels. Careful neurologic examination did not reveal any abnormal findings. The immediate provisional diagnosis was a deep thrombophlebitis with peripheral edema.

Because of the infection around the teeth, extraction was advised and was performed by an oral surgeon. Other treatment consisted of bed rest and physical therapy, following which the edema completely subsided after a week, with some alleviation of pain. He was dismissed from the hospital on Dec. 17, 1947. After leaving the hospital he wore an elastic leg bandage which reduced the swelling to a minimum.

On June 26, 1948, the patient returned because of severe lancinating pain in the left ankle. Examination at this time did not reveal anything unusual, except for some small varicosities around the ankle. Treatment at this time consisted of injection of the veins with a sclerosing solution. Contrast baths and elastic bandages were recommended.

On Sept. 10, 1948, the patient returned again because of recurrence of his symptoms. A roentgenogram of the ankle was taken and the roentgenologists

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thought there was possibly an old fracture of the talus. A plaster cast with a walking caliper was applied in order to relieve some pressure from the area of pain. After two weeks the cast was removed and the patient felt considerably improved. He was seen again on Nov. 28, 1948, at which time his symptoms had almost completely subsided.

This man was not heard from again until Feb. 10, 1951, at which time he was readmitted to the hospital complaining of severe lancinating pain in the left lower ankle and left heel. Large doses of morphine were necessary to control his pain. A careful physical examination did not reveal any neurologic change, nor was there evidence of any tumor in the lower leg. He stated that since his last admission he had been examined at a reputable clinic where his difficulty was attributed to vascular spasm. On the basis of this diagnosis, a parasympathetic block was performed. This in no way relieved his pain, but paradoxically increased it. Because of the trigger point in the lower left calf muscles, novocaine was injected locally into this area beneath the gastrocnemius muscle. The trigger point pain still persisted and the slightest pressure precipitated a severe pain. There was still no swelling or discoloration in this area.

From these examinations it was decided that a sympathectomy would be of no value, and that the diagnosis could not be made on the basis of vascular spasm. He was then told that all nonsurgical diagnostic possibilities had been exhausted and that only an exploration of this area might lead to the diagnosis.

Operation

On Feb. 14, 1951, the patient was operated upon. Under spinal anesthesia a longitudinal incision was made over the trigger point area in the lower leg. After opening the deep fascia and splitting the muscles, a tumor 10 by 4.5 by 4 cm. situated within the posterior tibial nerve was found. The tissue surrounding the tumor was apparently not involved and the tumor appeared well encapsulated. The tumor was resected, which left a long defect in the posterior tibial nerve. The only procedure that could be attempted with this much defect was a splicing and anastomosis. The wound was closed without drainage and a cast was applied to the foot.

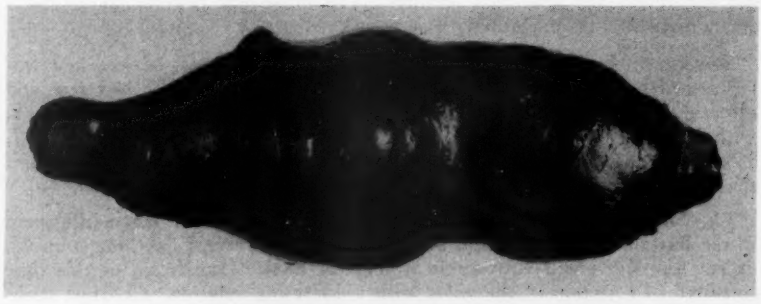

Fig. 1. Gross appearance of tumor.

The postoperative course was uneventful and, while he did not lose any function of his foot, there was a complete loss of sensation on the bottom of his foot. When the pathologic specimen was studied, the tumor proved to be a neurofibrosarcoma. On the basis of these findings an amputation was recom-

mended. A midthigh amputation was done on Feb. 24, 1951, and the patient made an uneventful recovery. When the leg was carefully examined by the pathologist he found that there were remnants of tumor cells remaining in the proximal end of the nerve.

On March 7, 1951, the patient was dismissed from the hospital. On Oct. 16, 1951, he was using a prosthetic appliance and had been walking with the aid of only one crutch. On Dec. 12, 1951, his general condition was excellent. A roentgenogram of the chest did not show any evidence of metastasis.

Pathologist's Report

Macroscopic. A tumor of the left leg is a fusiform, sausage shaped mass measuring 10 by 4.5 by 4 cm. and weighing 58 Gm. Four centimeters from one extremity there is a superficial circumferential constriction. The external surface appears to be completely invested by a smooth, pinkish-tan capsule. The surface is generally smooth but focally nodular. The largest nodule measures 1 cm. The sectioned surface reveals a bilobed tumor. The larger lobe is composed of soft, friable, pinkish-yellow tissue, much of which appears to be necrotic. The smaller lobe is composed of bright yellow tissue in which a moderate quantity of amber gelatinous material is present. Liquid substance issues from the cut surface in small quantities. At each extremity of the tumor there is a solid cylindrical structure resembling nerve which blends with or reflects on the periphery. At one extremity it measures 1 cm. long and 0.9 cm. in diameter. At the other extremity it measures 0.5 cm. long and 0.9 cm. in diameter.

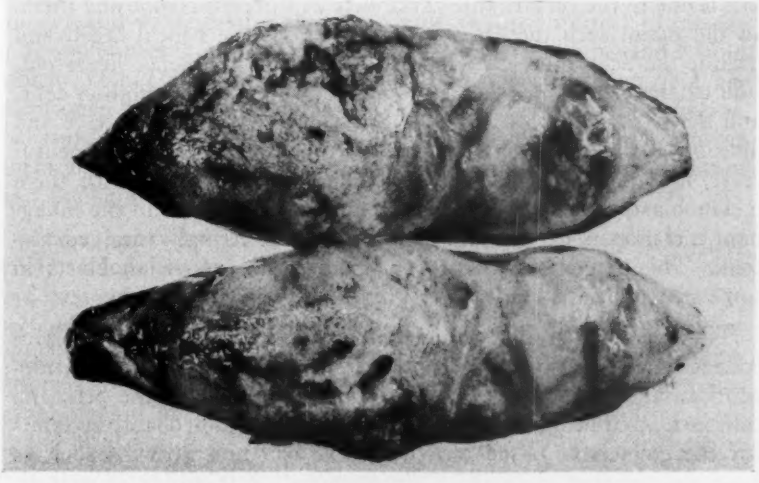

Fig. 2. Sagittal section of tumor.

Microscopic. Multiple sections show a cellular tumor conforming generally to the following description: cells arranged in closely packed whorls and fascicles, nuclei oval or spindle shaped, closely set, vesicular, medium to large, plump; moderate quantity of internuclear fibrillar tissue; relatively little variation in cell type; numerous mitoses. An occasional large hyperchromatic

vesicular nucleus and rarely dense hyperchromatic rounded cell is seen. The tumor tissue is mixed with fat and focally the capsule is invaded by tumor. Mixed with the predominant fibrillar tissue are clusters of small dark staining vesicular rounded nuclei, and polyhedral cells of medium size with distinct cell membranes. There is extensive focal necrosis and some cyst formation within the tumor. Small compact foci of lymphocytes are found within the tumor. A cross section of the nerve at one resected extremity shows large nerve bundles separated by an abundance of fibrous tissue infiltrated with moderate numbers of lymphocytes and no tumor tissue. A longitudinal section through the other resected extremity shows tumor tissue mixed with nerve fibers.

Diagnosis. Neurofibrosarcoma (figs. 1, 2).

Discussion

That tumors of the type described here are not common is reflected in a report from the Royal Alfred Hospital of Sydney, Australia. During the years 1910 to 1948 there were 360,672 admissions and of these there were only 146 cases of nerve tumors. The incidence, therefore, was 1 in 2,470. If amputation and scar neuromas are excluded, the incidence is even less. There were only two malignant schwannomas[1] in the 146 cases.

Tumors of the peripheral nervous system are relatively few in number, but richly varied in appearance and nature. Apparently this is due to the remarkable variability of the cells composing them. In the main, such tumors are derived from the neural crest, and include the Schwann cells which sheathe all of the nerve fibers outside of the central nervous system, the sympathetic ganglion cells, and the paraganglion cells. The Schwann cells are very active and multiply easily. Since embryologically they develop from the neural crest, it is possible and even probable that they bring with them melanoblasts which account for the pigmented moles and the malignant melanomas of the skin and certain ectodermally derived mucosa. This can also account for the presence of melanoblasts in some neurofibromas.

Tissue culture studies show that the Schwann cells can produce connective tissue fibers and, indeed, many believe that the endoneurium and perhaps the perineurium are formed by the Schwann cells instead of being mesodermal structures. This probably accounts for the connective tissue content of the common growths such as neuroma, neurofibroma and neurilemmona. A minority of writers, however, believe all of these are basically fibrous mesodermal growths.

In addition to connective tissue fibers, the Schwann cells of tumors are seemingly able to produce bone, cartilage, fat and striated muscle, a phenomenon not demonstrated in normal human beings

but known to be a function of derivatives of the neural crest (mesectoderm) in certain amphibia. Finally, cell derivatives of the neural crest can form tumors in the peripheral nerves which imitate the morphologic characteristics of central nervous system tumors. These neuroepithelial tumors, however, are exceedingly rare.

The more common malignant tumor derived from the sheaths of peripheral nerves has long been subject for debate because of the uncertainty as to whether it is a Schwannian growth (that is, a malignant schwannoma) or a fibrosarcoma derived from connective tissue cells (neurogenic sarcoma). Because of the great confusion and misunderstanding occasioned by the words "neurogenic sarcoma," the term "malignant schwannoma" is preferred for those tumors showing certain characteristic histologic features. The term "neurogenic sarcoma" should be abandoned because the word "sarcoma" has come to be associated with malignant tumors of mesodermal origin and it is uncertain whether or not the mesodermal elements of the nerve sheath can produce malignant fibrous tumors.

Multiple neurofibromatosis (von Recklinghausen's disease) produces a number of nerve sheath proliferations and occasionally malignant tumors. These are largely Schwannian, but they differ in certain respects from the solitary nerve sheath tumors (neurilemmona) and so deserve a separate name (neurofibroma). This disease sometimes induces the formation of certain tumors and lesions which are not in themselves composed of nerve elements, but are mentioned because of their association with this particular disease. Mention is also made of two tumor forms in which nerve fibers form an important component element, namely, the glomus tumor and the skin leiomyoma.

The tumors composed of cells which imitate the appearance of adult and embryonal sympathetic ganglion cells (ganglioneuroma and sympathicoblastoma) are highly specific and relatively easy to recognize as are the tumors composed of caricatures of the paraganglionic cells. These last tumors are generally called pheochromocytomas, if hormonally active in producing epinephrine, and paragangliomas if hormonally inert. Finally, there occur proliferations in the nose and orbit of heterotopic central nervous system tissue with the formation of both benign and malignant tumors.[2]

Summary

We have presented a case of a 63 year old white man with a massive neurofibrosarcoma of the posterior tibial nerve, weighing 58 Gm. and measuring 10 by 4.5 by 4 cm. The interesting features

of the case were the lack of clinical neurologic findings, as well as the bizarre symptoms which prevailed. Treatment consisted of resection of the mass, followed by midthigh amputation because of the pathologic findings of neurofibrosarcoma. The patient remains in excellent health 11 months after surgery.

REFERENCES

1. Money, R. A.: Tumors of peripheral nerves, Australian & New Zealand J. Surg. *19:*239 (Feb.) 1950.
2. Stout, A. P.: Tumors of the Peripheral Nervous System, Atlas of Tumor Pathology, Section II, Washington, Armed Forces Institute of Pathology, 1949, Fascicle *6:* F6-9, F6-10.

THE TREATMENT OF PECTUS EXCAVATUM OR FUNNEL CHEST

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Pectus excavatum is a congenital or developmental deformity in which the most obvious abnormality involves the sternum and the costal cartilages. However, these are by no means the only structures affected, for the cervical and dorsal spine and the ribs show pronounced changes. The thoracic viscera also show both anatomic and physiologic changes more or less directly attributable to the chest wall malformation. In individuals with pronounced maldevelopment of the anterior chest wall, it is apparent that the entire body is affected. They tend to be tall, slender and frail, the head and neck usually project forward at an ungainly angle, and frequently there is dorsal kyphosis and a scoliosis. The chest is narrow, flat and elongated, and the ribs join the spine at an acute angle and are more than ordinarily oblique. The sternal depression begins a little below the angle of Louis, and the maximum depression is at the sterno-xyphoid junction. The third through the seventh costal cartilages curve backwards to join the depressed sterum. The depression thus formed is elongated perpendicularly and often is distinctly funnel shaped. There often are transverse costal grooves which may be slight or pronounced, unilateral or bilateral. The most depressed segment of sternum may closely approach the vertebral bodies during inspiration, since in these individuals, the lower sternum moves paradoxically with respiration. In individuals with pronounced unlateral grooves, the depressed sternum is apt to be acentric. The heart may be fixed in the mid thorax, but usually is displaced to the left. Rarely, the heart is displaced to the right. The abdomen is protuberant, the liver may be ptotic, and breathing is noticeably abdominal.

While lung volume generally is reduced, the reduction rarely is sufficiently great to be significant. Dyspnea is common in individuals with marked deformity, but except in rare instances is it on a cardiac basis. In addition to dyspnea, those individuals with marked deformities are subject to pain which most often originates in the left chest and radiates to the left shoulder and down the left arm. Exercise tolerance is low since both pain and dyspnea are produced by exercise, sometimes by very limited exercise. On the

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other hand, some individuals with moderate or even marked sternal depression show a normal capacity for physical exertion.

The deformity may be present at birth and generally is recognized during the first few months of life. It is characteristically progressive, but there is considerable variation in the rate of progress and wide variation in the degree of deformity. Many causes for funnel chest have been suggested, including intrauterine pressure, overgrowth of the ribs, rickets, etc., but it seems almost certain that none of these is of etiologic importance. Brown suggested traction on the sternum by a shortened central tendon of the diaphragm as the principal cause, and this apparently has been accepted by the majority of observers. Lester states that the character of the deformity depends upon the part of the central tendon of the diaphragm which is shortened. If only the mid portion is short, there will be funnel chest, but no costal grooves. Shortening of the central and lateral segments gives rise to funnel chest and bilateral costal grooves. There are numerous variations depending upon the portion of the central tendon involved.

Although funnel chest was described in the sixteenth century and created a moderate amount of discussion in Europe in the latter part of the nineteenth century, it received little attention in this country until 1938. In that year Ochsner and DeBakey presented their remarkably complete review of the subject and this aroused considerable interest, especially among surgeons. The following year Brown made his rational suggestion as to etiology, and described his operation for the relief of the deformity. His operation was fundamentally sound, and was promptly accepted by a number of surgeons. A large proportion of the operations done today for the relief of this deformity are patterned after the Brown procedure although various modifications have been described. The important points in the operation for the correction of funnel chest are resection of the angulated segments of the costal cartilages, usually three through seven, on each side; excision of the xyphoid and division of those posterior fibers of the linea alba which extend up along the posterior surface of the sternum and are attached to it. Brown called this structure the substernal or retrosternal ligament. The attachments of the diaphragm to the posterior surface of the sternum must be separated so that the body of the sternum can be brought forward. All of these measures were recommended by Brown in his original paper. In addition, he recommended external traction by means of wire which was attached to an especially designed ladder that rested upon thick sponges, which were glued to the chest wall. He now believes it unnecessary to support the sternum other than by the

sutures which approximate the anterior sternal plate at the site of a wedge osteotomy. Ravitch also believes it is unnecessary to give other support to the sternum.

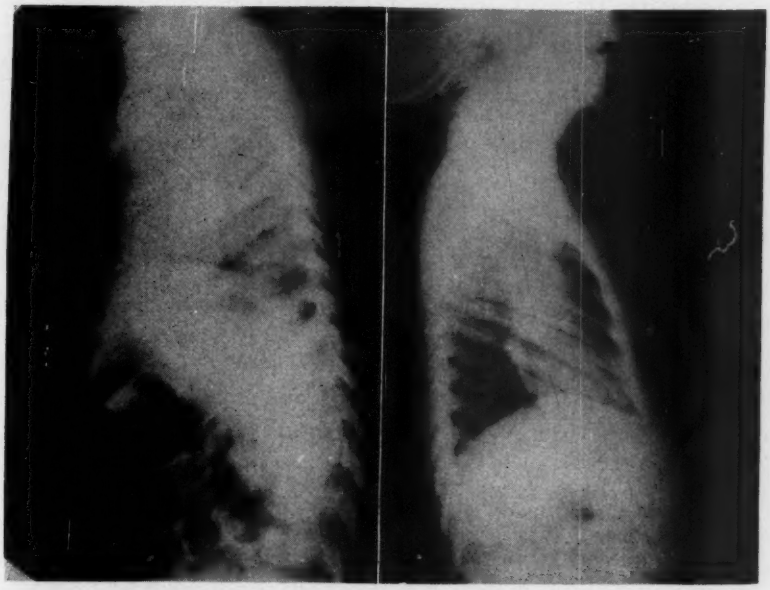

Fig. 1-a. Lateral roentgenogram of chest shortly after operation showing slight over-correction of the sternal deformity.

Fig. 1-b. Roentgenogram of chest seven months after operation showing slight recession of the sternum.

It appears, however, that the majority of surgeons give the sternum additional support in one way or another. Ochsner prefers to apply a light plaster shell over the anterior chest wall, attaching the sternum to it by elastic bands. Lester apparently continues to use a modified Brown ladder. Daily, Dorner, Bosher and others have used a section of rib to support the sternum. The rib segment is passed beneath the sternum, concave side forwards, and is fixed by wire to corresponding ribs. Brodkin uses a segment of cartilage, attaching it to the costal arch on each side, then fixing it beneath the lower end of the body of the sternum by wire sutures. We have used two or more strong sutures, passed beneath the sternum and through drill openings in the ends of corresponding ribs. These sutures are then tied under sufficient tension to support the sternum at the desired level. Steel wire No. 30 gauge, has been used in adults, and No. 32 gauge wire was used in one child. In another child we used Kangaroo tendon, thinking it might be undesirable to fix the ribs by nonabsorbable material in children. However, the

child on whom we used wire has shown less regression of the sternum (fig. 1), than has the child on whom Kangaroo tendon was used. These children, white boys 18 and 22 months of age, had approximately the same degree of deformity; both were free of symptoms, and both were generally healthy. The postoperative period has been too short to permit judgment as to the final result, but the child on whom we used wire was operated upon a few months before the other. Both of these boys tend to hunch their shoulders and, since they are still too young to cooperate in taking exercises, they have been referred to Dr. M. J. Hoover for orthopedic care and for braces.

We do not know which of the various methods of supporting the sternum is best, but we do believe it should be supported. It is difficult to see how one can avoid considerable paradoxical motion of the anterior chest wall when the sternum and ribs are so completely mobilized. Disturbing, and at times serious paradoxical motion occurs when there are extensive anterior and anterolateral rib fractures, especially when the sternum also is mobilized by fracture.

We prefer internal to external support. It seems to us that external support is clumsy and altogether unnecessary. Support by a semi-rigid structure such as rib or cartilage may well be the better method. The use of such a support would avoid any narrowing of the thorax by drawing the rib ends toward the mid line. This does occur, but probably not to a significant degree, when sutures are used to suspend the sternum between rib ends. On the other hand, securing the segment of rib and fixing it so that it will support the sternum adds to the operation. Also, it is likely that the use of either a rib or cartilage as a free graft increases the chance of infection.

Actually the exact technic used in supporting the sternum probably is of no great importance.

Certain cardiologists insist the deformity is not responsible for the cardiac symptoms and disability which patients with funnel chest so often are subject to. Evans, of the London Hospital, in a recent publication indicated that it was his belief that there was no direct connection between the chest wall deformity and the cardiac symptoms. This attitude is not easy to understand. It seems certain that marked displacement combined with rotation or torsion of the heart can seriously interfere with cardiac function, especially with cardiac filling. Furthermore, a very considerable number of patients have been relieved of their cardiac difficulties, some of them objectively demonstrable difficulties, by correction of the deformity.

While one would not recommend surgical correction of slight or even moderate deformities in adults, especially when there were no associated symptoms, operation seems in order in those individuals with marked deformities and with symptoms referable to these deformities. This appears to be a reasonable attitude, even in those instances in which the symptoms are the result of psychologic rather than physiologic disturbances.

The optimum age for correction of the deformity is not altogether certain. The term correction of the deformity is used to indicate that the complete or radical procedure is being considered. Lester, who has had an unusual experience in this regard, states that he has obtained his best results in children operated upon between 2 and 5 years of age. We believe this probably is the optimum period for surgery in those with confirmed funnel chest. After two years, one can decide with reasonable certainty whether or not the lesion is progressive and, therefore, whether correction of the deformity is necessary. Those children operated upon before 5 years of age, will not have developed irreversible changes in other structures as a result of the chest wall deformity. It has become increasingly clear that this does occur when marked deformities are allowed to go uncorrected until adulthood is reached. Even the cosmetic results are far from perfect under such circumstances. The sternocostal deformities may be almost completely corrected, but skeletal and visceral changes associated with funnel chest persist, and often are of greater importance than the funnel chest itself. Skeletal changes, such as spinal curvature, are not corrected. Even the displacement and torsion of the heart frequently is only slightly improved. The following case is illustrative.

Miss D. Mc., 34 years of age, was referred by Dr. Reno Porter for surgical correction of funnel chest because of increasing cardiac embarrassment. She stated that at 3 months of age her sternal deformity was sufficiently pronounced to cause her parents to consult a physician. At 14 years of age she developed dyspnea and chest pain, both of which persisted and became progressively worse. At 24 years of age she had worn a cast for a year in an effort to correct the deformity, but without benefit. The pain originated beneath the sternal depression and radiated to the left shoulder and down the medial aspect of the left upper arm. Occasionally she became dizzy, and twice within the year before operation she had blacked out. She was diagnosed as having rheumatic fever when she was 31 years of age, and was kept in bed for about six months; but that diagnosis was not confirmed.

Physical examination: A tall, slender, young, white woman with long, narrow, flat chest; ribs very oblique. Marked funnel chest and pronounced left costal groove (fig. 2).

Cardiac examination: Apical impulse visible and palpable in the posterior axillary line at the level of the angle of the scapula. A blowing systolic

murmur was audible at that area, and there was a loud systolic murmur over the pulmonic area. Heart rate 80 beats per minute, rhythm regular. Slight cyanosis. Electrocardiogram gave evidence of right ventricular strain. Fluor-

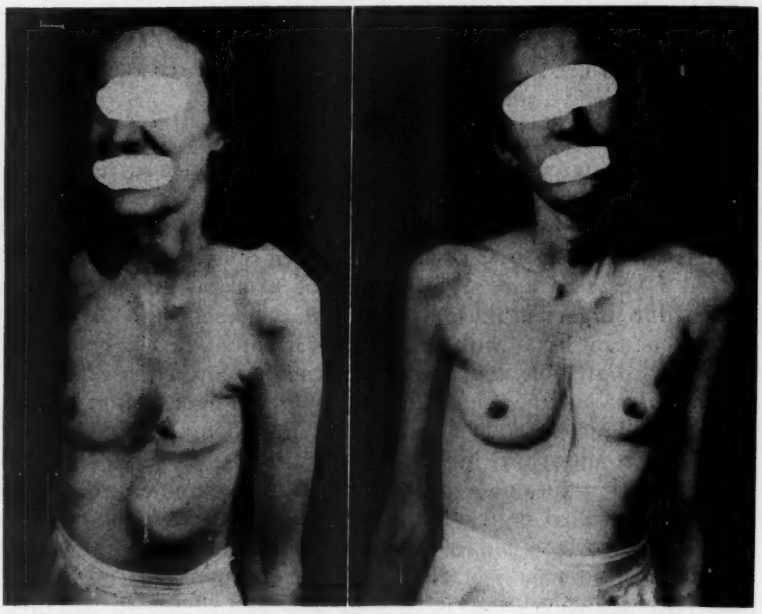

Fig. 2-a. Preoperative photograph showing marked funnel chest and left transverse costal groove.

Fig. 2-b. Postoperative photograph showing satisfactory correction of the deformity.

oscopy and roentgenograms showed marked displacement of the heart to the left with posterior rotation; considerable prominence of the pulmonary conus (fig. 3). Blood pressure was 130/90. The lungs were clear. Lateral chest plates revealed marked depression of the sternum with the lower portion not more than 2 cm. from the anterior surface of the bodies of the vertebrae. Her vital capacity was 3 liters (90 per cent of normal). There was scoliosis with the convexity to the right.

It was Dr. Porter's opinion that this patient's cardiac difficulty was due to the displacement and rotation of the heart, the result of the chest wall deformity. It also was his impression that the murmurs were not due to valvular disease, but to the displacement of the heart and torsion of the great vessels. In other words, it was felt that her incapacity was the result of the thoracic deformity and it would continue to progress unless that deformity was corrected.

Operation: Under intratracheal anesthesia the sternum and costal cartilages were exposed by a perpendicular incision, extending from the angle of Louis to below the xyphoid. Bilateral subperichondral resection of costal cartilages three through seven, from the sternum to near the costochondral junction, and Wedge osteotomy of the anterior plate of the sternum near the angle of Louis

were executed. The xyphoid was excised; the retrosternal ligament was divided; and the attachments of the diaphragm to the mediastinal surface of the sternum were separated. The sternum was suspended on no. 30 gauge stainless steel wire

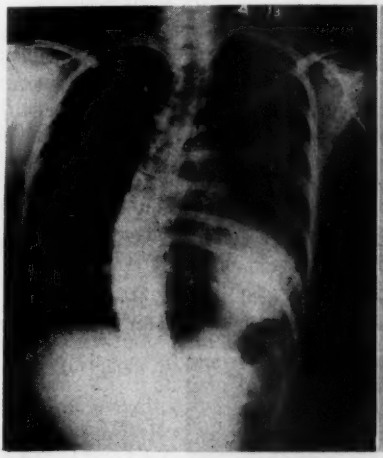

Fig. 3-a. Preoperative roentgenogram showing marked cardiac displacement.

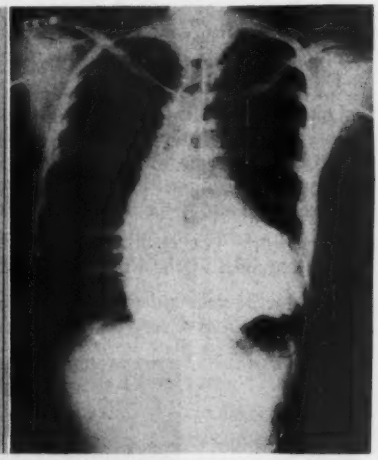

Fig. 3-b. Postoperative roentgenogram showing considerable persistent cardiac displacement despite satisfactory correction of the chest wall deformity.

sutures, passing from the fifth and seventh cartilages on one side, to the corresponding cartilages on the opposite side. A strand of medium silver wire was passed around the sternum, and was connected with overhead traction (5 lb. wt.) for the first six days. The wire broke on the sixth postoperative day, and to our surprise, the discontinuance of external traction appeared to have no adverse effect. As a result of this experience, we did not use external traction on our subsequent cases. The patient was out of bed on the eighth day. Convalescence was uneventful. This patient's cosmetic result is good, and there is somewhat less cardiac displacement. However, the functional result is less satisfactory. Four years postoperatively this patient states she still has chest pain, at times quite severe. However, she is now able to take deep breaths, and coughs less. She is no longer conscious of her heart shaking her body at each beat. She is obviously pleased with the improvement in her appearance. The psychologic effect has been good, and apparently there has been some improvement in cardiac function, but the latter is not pronounced.

Discussion: Although this patient has a rather satisfactory result in so far as correction of the chest wall deformity is concerned, she is excessively slender and has quite marked scoliosis. More important than any or all of the skeletal changes, she still has cardiac displacement and rotation, producing definite though not disabling symptoms. The over-all result is, therefore, somewhat unsatisfactory. Had her deformity been corrected before she had developed irreversible skeletal and visceral changes, the result likely would have been far more satisfactory.

During the past four years we have performed the radical or corrective procedure on 5 patients, including the one just described,

3 adults and 2 children. One of the adults was operated upon by Dr. Lewis Bosher who used a free rib graft to support the sternum.

Dr. Bosher's patient: A 27 year old white woman with moderately severe funnel chest, also complained of chest pain and dyspnea on exertion. These symptoms were of 18 months' duration. The pain radiated to the left shoulder and down the left arm.

Operation: The procedure was essentially the same as that described in connection with the previous case, except that a segment of the tenth left rib was used as a free graft for support of the sternum. The deformity was completely corrected; but there has been some recession of the sternum with slight recurrence of the deformity, and she still has some dyspnea on exertion.

Comment: The results in this patient are in every way comparable to the results obtained in the first patient, and the same comments are applicable.

C. B., a 24 year old white man, was referred by Dr. Reno Porter for surgical correction of a very marked funnel chest. He had long been handicapped

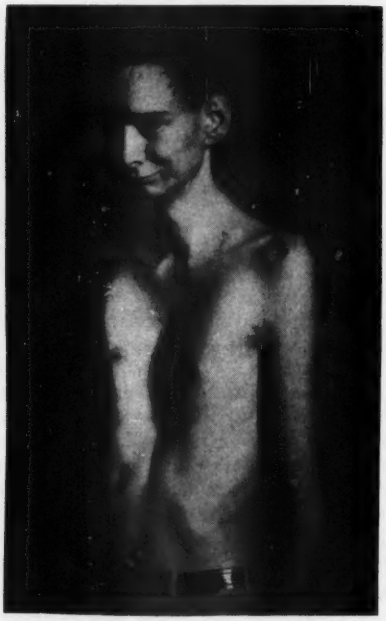

Fig. 4. Photograph showing example of extreme degree of sternal depression, but with little or no evidence of lateral costal grooves. The position of the head and the long thin chest are characteristic.

by his deformity, but for the past year he had been increasingly dyspneic and within the past few weeks had become quite breathless even on slight exertion. Twenty-four days before entering the Medical College of Virginia Hospital he suddenly became markedly dyspneic, his heart pounded rapidly and violently, and he suffered severe substernal pain. He was hospitalized for two

weeks during which time he had a second episode of pain and rapid, violent heart action. Following the first of these attacks his dyspnea was progressive, and he also became orthopneic.

Physical examination revealed a slender, underdeveloped, undernourished man, somewhat dyspneic even at rest. His expression indicated that he was uncomfortable and unhappy but not in actual pain (fig. 4). His neck extended forward from the shoulders in the characteristic manner. The chest was long, narrow and thin, the ribs were very oblique and there was an unusually pronounced depression of the sternum. The heart was markedly displaced to the left, the point of maximum intensity being in the mild axilla at the level of the seventh and eighth interspaces. The left chest wall heaved visibly with each heart beat. There was a loud, harsh continuous machinery-like murmur over the base of the heart, and a systolic thrill was felt over the same area. His blood pressure was 90/40 in right arm, and 110/32 in left arm.

Operation, Nov. 5, 1949: The operative procedure was in all essentials similar to that performed on the first patient. The sternal deformity was completely corrected. The patient withstood the operation well, and remained in satisfactory condition for 48 hours.

On the second postoperative day, he suddenly went into circulatory collapse and died within less than two hours, notwithstanding administration of blood, oxygen, etc. There was marked distention of the cervical veins, even when there was no demonstrable arterial pressure. This suggested cardiac compression, but there was no apparent cause for such a development.

Autopsy report by Dr. G. R. Hennigar, Department of Pathology, Medical College of Virginia. The appearance was that of an asthenic, poorly developed, white man. His length was 72 inches. Numerous comedos were seen on his face. A recent surgical incision extended down the mid sternal line to just beyond the xyphoid. Cartilages three to seven were bilaterally absent. The arms and legs were very slender and long with poor muscular development. The left leg was shorter than the right, and there was a partial club foot. The first and second toes bilaterally were longer than normal. Both fourth toes were shorter than the other toes. There were flexion deformities of the fingers of both hands. The teeth were deformed with resulting malocclusion. The uvula was bifid. Lumbar kyphosis was evident.

The approximate weight of the heart was 500 Gm. The increase in weight and size was due to left ventricular hypertrophy and dilatation. The pericardial sac contained 880 cc. of blood.

The ascending aorta and first portion of the arch were markedly dilated, measuring 8 cm. in diameter. The aorta in this portion was "double-barreled," the result of a chronic dissecting aneurysm. A small intimal tear was demonstrated 3 cm. above the aortic ring. On the anterolateral surface of the right side of the aorta, 4 cm. above the aortic ring, there was a small perforation or rent in the outer wall of the aneurysm connecting the lumen with the pericardial sac. This was the route through which blood entered the pericardial sac, producing fatal cardiac compression. There was a slight narrowing, suggesting a minimal coarctation in the segment of the aorta lying between the left subclavian and left common carotid arteries. Just distal to the origin of the left subclavian artery, a second dissection began which extended throughout the remainder of the aorta, and involved the first portion of both iliac arteries.

Histologically, the lumens of both dissections were endothelialized and some atheroma were present. The lumen of the aorta proper showed marked subintimal fibrosis. The media of the aorta revealed the presence of basiphilic material in which many cysts were seen. This material stained metachromatic with toluidine blue, and was considered to be mucopolysaccharide in nature. The remainder of the findings were not considered significant.

Anatomical diagnosis: Multiple congenital deformities. Chronic dissecting aneurysm with rupture into the pericardial sac.

Pathological discussion: The congenital deformities constitute what is frequently referred to as Marfan's syndrome, a condition in which many of the findings are accounted for on the basis of defective mesenchyme. The media of the aorta was the "seat" of cystic medionecrosis of Erdheim which we believe is in the background of all dissecting aneurysms. This change is a peculiar affection of the mesenchyme and intercellular substance of the media. Reports of the finding of dissecting aneurysms in Marfan's syndrome are not uncommon.

Comment: While operation obviously was not directly responsible for this man's death, the change in intrathoracic pressure incident to elevation of the anterior chest wall, probably precipitated rupture of the friable aneurysmal wall. The cause of the quite remarkable murmur, loudest over the base of the heart, was discussed at length, but the condition demonstrated at autopsy was not considered. In retrospect, it might well have been thought of because of the character and multiplicity of his developmental defects. It is assumed that there was no cause and effect relationship between the funnel chest and the aneurysm. It was realized, however, that this man was a poor surgical risk, but he was rapidly approaching complete incapacitation, so operation was recommended.

In addition to his corrective or radical procedure, Brown described a conservative or preventive operation which he now believes should be performed in very young infants who are developing funnel chest. It consists essentially of excision of the xyphoid, division of the substernal ligament and separation of the attachments of the diaphragm from the posterior surface of the sternum. No cartilages are resected and the sternum is not osteotomized. Lester uses this conservative procedure in some young infants. We have had no experience with it.

Summary

Even if children who have had the corrective operation eventually develop some degree of recurrence of the funnel chest, it is extremely unlikely that they will develop pronounced changes in other structures, such as the spine and the thoracic viscera. If these associated changes can be prevented, the operation will have justified itself.

This operation has not been applied to a sufficient number of children and those operated upon have not been followed for a long enough period to determine with certainty the final result. However,

Lester has followed a number of such cases for several years, and is reasonably well satisfied with the results. On the other hand, it can be definitely stated that adults, operated upon for advanced funnel chest, will not be relieved of many of the most disturbing associated changes, even though the sternal deformity be entirely corrected. With these considerations in mind, it seems reasonable to recommend surgical correction of the chest wall deformity in children with funnel chest whose deformity is known to be increasing.

REFERENCES

1. Bosher, L.: Personal communication, 1952.
2. Brodkin, H. A.: Congenital chondrosternal depression (funnel chest). Its treatment by phrenosternolysis and chondrosternoplasty, Dis. Chest *19*:288 (March) 1951.
3. Brown, A. L.: Pectus excavatum (funnel chest) anatomic basis; surgical treatment of incipient stage in infancy; and correction of deformity in fully developed stage, J. Thoracic Surg. *9*:164 (Dec.) 1939.
4. Daily, J. E.: Discussion of Dorner's paper.[5]
5. Dorner, R. A.; Keil, P. G., and Schissel, D. J.: Pectus excavatum; case report with pre- and postoperative angiocardiographic studies, J. Thoracic Surg. *20*:444 (Sept.) 1950.
6. Evans, W.: Heart in sternal depression, Brit. Heart J. *8*:162 (July) 1946.
7. Lester, C. W.: Surgical treatment of funnel chest, Ann. Surg. *123*:1003 (June) 1946.
8. Lester, C. W.: Funnel chest and allied deformities of thoracic cage, J. Thoracic Surg. *19*:507 (April) 1950.
9. Lester, C. W.: Personal communication, Feb. 6, 1952.
10. Ochsner, A., and DeBakey, M.: Chone-chondrosternon; report of case and review of literature, J. Thoracic Surg. *8*:469 (June) 1939.
11. Ravitch, M. M.: Operative treatment for pectus excavatum, Ann. Surg. *129*:429 (April) 1949.
12. Ravitch, M. M.: Pectus excavatum and heart failure, Surgery *30*:178 (July) 1951.

DIFFICULTIES IN THE DIAGNOSIS OF CARCINOMA OF THE ESOPHAGUS

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ALTHOUGH there have been many advances in the surgical therapy of carcinoma and other diseases of the esophagus in the past decade, still the results obtained in the treatment of carcinoma leave much to be desired.[1,2,3,4] In any review of a large series of cases of carcinoma of the esophagus embracing all rather than selected cases, the poor results indicates clearly the need for careful scrutiny of the reason or reasons therefor.

Accordingly, we have reviewed the records of 170 cases of primary epidermoid carcinoma of the esophagus, all proved histologically, seen in the clinics of the Medical College of South Carolina and in the Roper Hospital between January 1940 and July 1951. Among several, it was learned[3,4] that certainly one of the most important reasons for the poor results was that of failure to establish the diagnosis before the patient had experienced a considerable loss of weight and strength as a result of the starvation to which these patients are particularly subject. In other words, the index of suspicion was very low or absent on the part of the physician first consulted at the time of the onset of symptoms. However, on analyzing the records of these patients and of those seen subsequently, there were 17 cases found in whom there became apparent additional important reasons for delays in diagnosis.

In this article, these reasons will be set forth, and exemplified by appropriate brief case histories.

At the outset, it may be stated that most patients having carcinoma of the esophagus have a sense of obstruction on swallowing and a filling defect in the esophagus on roentgenologic examination. Usually the physical examination is noncontributory except for evidence of loss in weight and strength, because the esophagus is inaccessible to examination except for the very short cervical segment which is infrequently involved in carcinoma. Therefore, it is to be expected that the reasons for difficulties in establishing early diagnosis would be encountered most frequently in those patients not presenting both of the above most commonly observed features of carcinoma of the esophagus. Also difficulties might be expected in

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those in whom there is a spontaneous but temporary disappearance of the dysphagia; those in whom two or more esophagoscopic examinations are necessary; and those in whom the symptoms are blamed erroneously upon some more readily demonstrable coexistent physical abnormality.

Unfortunately, the case histories can not be illustrated by photographs of roentgenograms of the esophagus in that exceedingly important group of patients who have some symptom referable to swallowing or eating; in whom the roentgenologic studies of the esophagus are normal even though carcinoma is known to be present. This is because of the custom of roentgenologists of not making roentgenologic films in the absence of any demonstrable abnormality in the esophagus upon fluoroscopic observation using barium as a contrast medium. Nevertheless, it is believed that the case histories alone will be sufficiently clear to compensate for this deficiency.

The following case demonstrates one in whom the symptom of dysphagia was absent early in the course of the disease.

CASE 1. I. W., a white man 46 years of age, who was admitted in September 1947 complaining of hurting all over, pellagra, sore throat, and of burning in the throat on swallowing food. He had been intoxicated for the previous three weeks and complained also of anorexia, nausea and vomiting. On examination, there was evidence of malnutrition, pellagra and anemia. The clinical impression was that of so-called sideropenic dysphagia. Roentgenograms of the esophagus showed a mild dilatation in the lower portion. Esophagoscopy was performed and the findings were normal except for evidence of leukoplakia in most of the thoracic esophagus. There was no ulceration or stricture or other obstruction. A random biopsy specimen was taken at a level of 30 cm. beyond the alveolar margin, solely for academic purposes in order to study the mucosa in so-called sideropenic dysphagia. Much to everyone's surprise the microscopic examination of the tissue revealed epidermoid carcinoma in the submucosa. The overlying mucosa was normal. The esophagoscopy was repeated. The site of the previous biopsy specimen was not recognizable. There was no definite abnormality except for evidence of leukoplakia. Another biopsy specimen was taken at the 30 cm. level and the microscopic section showed only esophagitis. Roentgenologic studies of the esophagus were repeated and these were normal. Laryngoscopy was performed next and a large ulcer of the epiglottis was found. Biopsy specimen of this showed epidermoid carcinoma. The carcinoma of the esophagus was considered inoperable at the time because of the significant degree of malnutrition which the patient presented. Therefore a gastrostomy was performed. Roentgenotherapy was given over the larynx. Another esophagoscopy was performed. On this occasion there was a polypoid-like mass at the 35 cm. level. A biopsy specimen of this was obtained and showed epidermoid carcinoma. This was considered to be an entirely separate site of carcinoma from the first.

He was followed in the clinic. The sore throat and pain on swallowing disappeared after roentgenotherapy of the epiglottis was completed. In Janu-

ary 1948, esophagoscopy was performed again. Except for leukoplakia, no further carcinoma was found although biopsy specimens were taken at two suspicious sites. On this examination a papilloma was found at the base of the tongue. A biopsy specimen of this also showed epidermoid carcinoma.

Again he was followed in the clinic. He was able to eat anything. He used the gastrostomy very little and gained 10 pounds. Esophagoscopy was performed again in February 1948 and on this occasion epidermoid carcinoma with very slight narrowing was found at the 37 cm. level which was proved by biopsy specimen. There was no subjective or objective obstruction in the esophagus before this time. He continued to swallow well until April 1948 when a sense of obstruction at the level of the xiphoid developed. In May 1948 roentgenologic examination of the esophagus showed an irregular constriction at the level of the eighth thoracic vertebra. Thereafter he had progressively increasing dysphagia and a downhill course with death in August 1948. At autopsy residual carcinoma of the epiglottis was present. There was only one carcinoma found in the esophagus, 5 cm. beyond the carina, with no extension beyond the esophagus.

The following history illustrates a terminal case of carcinoma of the esophagus occurring without any encroachment on the lumen, therefore without esophageal obstruction, and without the symptom of dysphagia.

CASE 2. M. B., a Negro woman 47 years of age who was seen first in 1944 and found to have epidermoid carcinoma of the cervix. This was treated with radium and roentgenotherapy with no evidence of recurrence thereafter. In August 1945 she was seen in the clinic complaining of a cough. Again on two occasions in December 1945 she came to the clinic because of a brassy-cough and there was evidence of tracheal obstruction. However, roentgenograms of the chest were normal. There was no note of any difficulty in swallowing. She was not seen again until May 1947 when she was admitted to the hospital because of profound illness. There was a history of a cough with foul sputum for eight months and a loss of 30 pounds of weight in the previous year. The cough was brassy and there were course rales throughout both lungs. A Horner's syndrome was present on the right. She was markedly dyspneic and using the accessory muscles of respiration. There was retraction of the intercostal spaces on inspiration. Bronchoscopy was performed and the trachea was found to be narrowed at the thoracic inlet. Next a mediastinotomy was performed and a nonresectable tumor was found in the posterior superior mediastinum. A biopsy of this revealed epidermoid carcinoma. Shortly thereafter she died. Autopsy revealed epidermoid carcinoma of the esophagus which was manifested in the mucosa only as a very small plaque-like elevation. There was no obstruction or encroachment upon the lumen. There was extensive invasion of the superior mediastinum including invasion and compression of the trachea.

The following history illustrates a case in whom there was a spontaneous disappearance of dysphagia accounting for a delay in adequate study for the possibility of the presence of carcinoma of the esophagus.

CASE 3. C. B., a Negro woman 48 years of age, was seen in the clinic in August 1948 complaining of a hurting feeling of three months duration and

of food stopping opposite the lower end of the sternum. She was unable to swallow solid foods and had to drink water to wash other food down. There had been a loss of 10 pounds in weight. The clinical impression was that of esophageal obstruction and she was admitted to the hospital for further study. The physical examination was not remarkable. She was described as being obese. While in the hospital her symptoms disappeared and roentgenologic studies of the esophagus, stomach and duodenum were normal. Therefore a diagnosis of gastric neurosis was made and she was advised to have further roentgenologic studies of the upper alimentary tract and esophagoscopy only if the symptoms recurred. She was not seen again until March 1950 when she was admitted to the hospital in extreme respiratory distress. There was no accurate history available for the interim period, but apparently she had been having difficulty in breathing and swallowing since September 1949. Roentgenologic studies of the esophagus showed an extensive filling defect from the level of the first to the seventh thoracic vertebra. The mediastinum was widened and there was very poor aeration in both lungs. An emergency tracheotomy was performed and there was found a large tumor mass behind and around the trachea and esophagus. Biopsy specimen of the tumor showed epidermoid carcinoma. Shortly thereafter the patient died because of persistent obstruction of the trachea below the level of the tracheotomy. Permission for autopsy was not granted, but it is believed that the carcinoma was primary in the esophagus.

It is reasonable to believe that the patient had carcinoma of the esophagus at the time of the first appearance of dysphagia before this disappeared spontaneously. Also it is reasonable to believe that esophagoscopic examination was indicated at the time when the roentgenologic studies of the esophagus were normal.

The following histories illustrate cases having normal roentgenologic studies of the esophagus in the presence of histologically proved carcinoma at the time or soon thereafter.

CASE 4. J. L., a Negro man 48 years of age, who was admitted to the hospital in November 1946 because of a strangulated ventral hernia as a result of a gunshot wound of the abdomen incurred in 1919. He had an operation for the hernia with an uneventful recovery. By April 1947 while being observed in the clinic, recurrence of the hernia became apparent and another operation for repair of the hernia was being considered. In June 1947 while returning to the clinic as instructed he began to complain of burning in the stomach extending up into the throat. On a second visit in June 1947 he complained of continued dysphagia; of a lump in the middle of his chest; and of pain under the right scapula relieved by belching. Roentgenologic studies of the upper alimentary tract at this time revealed a normal esophagus, stomach and duodenum. In July 1947 he complained of a gripping and squeezing sensation beneath the sternum associated with gas formation and eructation. In view of the normal roentgenologic studies the impression was that of possible coronary disease and he was treated with nitrites. His complaints continued so cholecystograms were obtained and these were normal. Also he was given belladonna and phenobarbital. Throughout August he complained of substernal pain. A barium enema was given and this was normal. Roentgenograms of the chest and an electrocardiogram were normal. In September 1947 while presenting the same complaints it was noted that he had lost 31 pounds in weight since June 1947. Therefore he was admitted to the hospital for

further study. On admission the history was the same. The physical examination was not remarkable except for evidence of loss in weight. There was a marked anemia. Roentgenogram of the esophagus showed a filling defect in the mid-thoracic region. Esophagoscopy showed that the lumen was narrowed to a slit 25 cm. beyond the alveolar margin. A biopsy specimen showed epidermoid carcinoma. Exploratory thoracotomy was performed and the lesion was considered to be nonresectable. A gastrostomy was performed for feeding purposes but he had a progressively downhill course and died in November 1947, six months after the onset of symptoms.

CASE 5. L. B., a Negro woman 55 years of age, was admitted in November 1949 complaining of loss in weight, continuous pain in the epigastrium, vomiting of all foods and fluids ingested and a sensation of obstruction on swallowing opposite the lower border of the sternum. All symptoms were of sudden onset three weeks before admission. Weakness had become so great she was hardly able to walk. Physical examination was not remarkable except for evidence of loss in weight and strength and a palpable node in the left supraclavicular fossa. The clinical impression was that of probable carcinoma of the stomach. Roentgenologic studies of the upper alimentary tract showed no evidence of obstruction or any intrinsic lesion in the esophagus, stomach or duodenum. However, the esophagus was examined fluoroscopically only in the right anterior occipital position. Esophagoscopy was performed and a nodular tumor was found on the anterior wall of the esophagus 37 cm. beyond the alveolar margin. A biopsy specimen of this showed epidermoid carcinoma. Therefore the roentgenologic studies were repeated. Again the esophagus was normal in the right anterior occipital position, but in the lateral and the left anterior occipital positions a definite filling defect without obstruction was noted. Laparotomy was performed and a large metastatic nodule was found in the liver. Therefore the lesion was considered incurable. She died in June 1950 after a progressive downhill course.

The histories of the 2 patients in cases 4 and 5 and also that of case 1 illustrate examples of patients with normal roentgenologic studies of the esophagus in the presence of histologically proved carcinoma of the esophagus. In any patient with any symptom referable to swallowing, esophagoscopy is indicated because of the possibility of carcinoma regardless of what the roentgenologic studies reveal.

The following history illustrates a patient in whom roentgenograms of the esophagus demonstrated an abnormality but in whom esophagoscopy was normal on the first examination.

CASE 6. G. C. P., a white man 67 years of age, who was admitted in September 1951 complaining of inertia and lassitude of six weeks duration. Also since June 1951 he had had burning epigastric pains extending up into the low substernal region. The pains occurred after meals and after lying down at night. There was some anorexia and there had been a slight loss in weight. There was no dysphagia, nausea or vomiting. The bowel movements were normal. The physical examination was not remarkable. Prior to examination he was observed to eat a very large meal without any dysphagia whatever. Roentgenograms of the esophagus showed a marked irregularity in the lower

third. However, the irregularity smoothed when the esophagus was filled to a maximum. The roentgenologic impression was that of varices. Esophagoscopy was performed. The mucosa was entirely normal down to the cardia at the 42 cm. level. No varices or any other abnormality were found. The examination was very careful because the clinical impression was that of definitely possible carcinoma. It was recognized that even if varices were present they did not explain the symptoms. The patient was advised to return in four weeks for further observation. On re-admission in November 1951 he gave the history that dysphagia began one week following his previous discharge from the hospital. This was progressive until he could swallow only liquids. The pains persisted and he had considerable loss in strength and 14 pounds loss in weight. On examination on this occasion he was chronically ill. There was a mass in the epigastrium and left upper quadrant. Roentgenograms of the esophagus showed again a marked irregularity in the distal esophagus. On this occasion there was slight stiffening of the walls and evidence of the presence of minute ulcers. Again the roentgenologic impression was that of extensive varicosities. Esophagoscopy was repeated and an ulcerating obstructing lesion was found at the 36 cm. level. A biopsy specimen of this showed epidermoid carcinoma. Laparotomy was performed and revealed extensive tumor in the left upper quadrant. Therefore the lesion was considered incurable. The patient died in February 1952 after a progressive downhill course.

In this case, it is extremely interesting that in spite of roentgenologic evidence of a marked deformity in the lower end of the esophagus on the first admission and in spite of a very careful esophagoscopic examination because of the clinical impression of possible carcinoma, no abnormality was found until eight weeks later when complete obstruction due to obvious extensive tumor was found 6 cm. above the cardia.

The following histories illustrate examples of patients with symptoms referable to the esophagus but in whom carcinoma was not considered initially because of some other obvious physical defect.

CASE 7. L. W., a Negro woman 35 years of age, who was in the hospital in January 1948 with a history of a recurring knot of three months duration in the abdomen and other symptoms consistent with intestinal obstruction. She had a laparotomy with lysis of adhesions. There was no recurrence of intestinal obstruction. At that time her blood pressure was 215/110. During later observations in the clinic it was observed that her blood pressure was as high as 290/140. She was re-admitted to the hospital in January 1950 with cardiac failure and mild encephalopathy. She had been taking digitalis for the previous six months. Her blood pressure at that time was 250/120. On further observation in the clinic in April 1951 she began to complain of difficulty in swallowing and anorexia. At this time, these symptoms were ascribed to drugs, particularly to digitalis, CH-27 and diquinol, all of which she was receiving. It was then decided to perform bilateral sympathectomy for hypertension for which she was admitted to the hospital in May 1951. On admission her chief complaints were those of dysphagia of several months duration and of having to drink water with solid foods. The clinical impressions were those of hypertension and possible peptic ulcer. Also at this time a review of the observations on her weight revealed that she had for no definite reason lost 30 pounds in weight since February 1951. A right thoracotomy was performed on May 11, 1951 for sympathectomy from the third thoracic

vertebra through the first lumbar vertebra including the greater and lesser splanchnic chains. Ten days later a barium swallow revealed a filling defect considered to be possibly due to carcinoma. However, this was apparently overlooked. A second stage sympathectomy was performed on the left on May 30, 1951. In June 1951 she continued to complain of epigastric and substernal pain with vomiting and therefore the roentgenologic studies of the esophagus were repeated. These revealed a defect in the mid-portion of the thoracic esophagus. Esophagoscopy was performed and an ulcerated obstructing lesion was found 30 cm. beyond the alveolar margin. The biopsy specimen showed epidermoid carcinoma. Next a left thoracotomy was performed for an intended esophageal resection, but due to cardiac difficulties the operation had to be discontinued. In spite of roentgenotherapy for the carcinoma of the esophagus, a gastrostomy for feeding purposes, and nitrogen mustard therapy, she died in October 1951 after a progressive downhill course, seven months after the onset of dysphagia.

CASE 8. J. F., a Negro man 64 years of age, was seen first in the clinic in August 1947 complaining of gas in the chest. A roentgenogram of the chest at that time was normal. On a second visit to the clinic in the same month he complained of pain on swallowing. A barium swallow was ordered but was not done. However, a roentgenologic examination of the stomach and duodenum, using barium, was normal except for the possible presence of a diverticulum in the duodenum. He returned to the clinic in August and September 1947, on each occasion complaining of burning in the chest on swallowing. He did not return again until November 1948, at which time he complained of difficulty in swallowing and on a second visit in the same month he complained of hoarseness also. He was admitted to the hospital for further study in December 1948. At that time he was still able to swallow but it was exceedingly painful. There had been no regurgitation. Roentgenograms of the esophagus revealed evidence of carcinoma. On esophagoscopy there was a fungating obstructing tumor 25 cm. beyond the alveolar margin. The biopsy specimen showed epidermoid carcinoma. The vocal cords moved normally. However, a roentgenogram of the chest at this time showed evidence of numerous metastases in the left lung. Because of the metastases in the left lung, the tumor was considered inoperable and gastrostomy was performed. Thereafter his course was progressively downhill. He developed extensive metastases in both lungs, and died in April 1949.

It is believed that in the above case, the possible diverticulum in the duodenum was responsible for distracting attention from the possibility of primary disease of the esophagus during the time that the patient was visiting the clinic in 1947.

CASE 9. M. G., a Negro woman 69 years of age, came to the clinic in January 1947 complaining of food sticking substernally after eating. The clinical impression was that of cardiospasm. Roentgenologic studies of the upper alimentary tract revealed the fact that the esophagus was normal. She was not seen again until February 1948, when she was admitted to the hospital because of nervousness. At this time she gave a history of dysphagia in 1946. No definite conclusion were reached and she was discharged from the hospital. She was re-admitted to the hospital in October 1948 with the chief complaint of food stopping before it got to the stomach and causing pain, of one year's duration. Also she complained of severe pain in the right upper quadrant with vomiting of four days' duration. She was found to be jaun-

diced. Cholecystograms failed to reveal any shadow of the gallbladder and it was considered that she had acute cholecystitis. Laparotomy was performed and cholecystectomy for cholelithiasis was performed. There was no evidence of any stones in the common duct. An incidental appendectomy was performed. Her recovery was uneventful but she was re-admitted to the hospital in February 1949 complaining that "it hurts my stomach when I eat." Also she had soreness in her chest of 18 months duration. She stated that she could swallow anything but that solid food caused pain. She had lost 30 pounds in the previous year. Roentgenologic studies of her upper alimentary tract revealed a filling defect in the esophagus. Esophagoscopy showed a small obstructing ulcer 34 cm. beyond the alveolar margin. A biopsy specimen showed epidermoid carcinoma. A roentgenogram of the chest was normal. An esophageal resection was performed and the continuity re-established by intrathoracic esophagogastrostomy. It was found that the lymph nodes were involved. Her recovery from the operation was very satisfactory but she died in August 1949 because of residual carcinoma in the mediastinal lymph nodes invading the stomach near the site of anastomosis.

It is desired to call attention also to the fact that case 6 represents a patient in whom two esophagoscopies were necessary in order to establish the diagnosis of carcinoma of the esophagus.

Too, it is desired to point out that case 6 also represents a patient in whom exploratory thoracotomy would have been the only method of definitely establishing the diagnosis upon first observation. It is realized that this is probably not an acceptable procedure at the present time, but it is also believed that if one is to make a diagnosis of carcinoma of the esophagus at the earliest possible stage, there will arise instances when exploratory thoracotomy for examination of the esophagus at a suspicious level will be necessary.

Discussion

Carcinoma of the esophagus is a highly fatal disease. It will be exceedingly difficult if not impossible to improve the results of surgical treatment unless greater effort is made to establish earlier diagnoses than has been practiced in the past.

Earlier diagnoses can be established except in the unusual case in whom the character of growth of the tumor is such as to result in no ulceration of the mucosa in which case there is no pain or discomfort on swallowing. And such as to result in no encroachment upon the size of the lumen in which case there are no signs of obstruction on swallowing.

The methods of diagnosis available during life at present, are the evaluation of the history and physical examination, roentgenologic and esophagoscopic examination of the esophagus. Also it is conceivable that exploratory operation would be necessary in rare instances in order to establish the diagnosis. In any case, histologic

proof of the diagnosis is always necessary for accuracy. Except in rare instances, this proof can be obtained by esophagoscopy and biopsy specimen. As long as we are limited to our presently available technics of therapy for carcinoma of the esophagus, and to our presently available methods of diagnosis, it is essential that these diagnostic methods be used to the utmost in the interest of earlier diagnosis.

In this regard, it is apparent from the above case reports that roentgenologic examination of the esophagus as the sole examination accessory to the history and physical examination is inadequate to determine the presence or absence of carcinoma of the esophagus.

Roentgenologic examination may not allow one to detect the presence of a small filling defect in the esophagus. Obviously the smaller the defect, presumably the earlier the tumor is in its malignant course, and therefore the greater the desirability of determining its presence. Thus, in any patient with any symptom referable to swallowing or eating, especially with pain or a sense of obstruction on swallowing, esophagoscopy is indicated even if the roentgenologic examination is normal. This represents a variation in our former concept to the effect that esophagoscopy was indicated only to confirm by direct observation and biopsy specimen the character of the lesion as observed by roentgenologic examination. This former concept must be changed. Esophagoscopy must be considered an essential procedure in the diagnostic study of any patient in whom the presence of carcinoma is even remotely possible.

Summary

1. Considering the extremely poor results of the treatment of carcinoma of the esophagus by present technics, every effort must be made to obtain improvement.

2. One of the essentials for improvement in the results of treatment must be in exercising greater care to establish the diagnosis as early as possible in the course of the disease.

3. The utilization of all diagnostic methods now available must be realized on a greater scale.

4. It is stressed the esophagoscopy must be considered as an indispensable method of examination in any patient in whom the possibility of carcinoma of the esophagus is even remote.

5. Also it is stressed that esophagoscopy must be included as a method of study in the patient with possible carcinoma of the

esophagus, even if roentgenologic studies of the esophagus are normal.

6. Illustrative case reports are cited to support the above views.

REFERENCES

1. Gibbon, J. H., Jr.; Albritten, F. F., Jr., and Templeton, J. Y., III: Carcinoma of the esophagus and gastric cardia, J.A.M.A. *145:*1035 (April) 1951.
2. Sweet, R. H.: The results of radical surgical extirpation in the treatment of carcinoma of the esophagus and cardia with five years survival statistics, Surg., Gynec. & Obst. *94:*46 (Jan.) 1952.
3. Parker, E. F., Hanna, C. B., and Postlethwait, R. W.: Carcinoma of the esophagus, Ann. Surg. *135:*697 (May) 1952.
4. Hanna, C. B., et al: Carcinoma of the esophagus, J. South Carolina M. A. *48:* (Feb.) 1952.

TREATMENT OF CARCINOMA OF THE TONGUE AND FLOOR OF THE MOUTH*

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THIS discussion of the treatment of malignant tumors of the oral cavity includes carcinoma of the tongue, floor of the mouth, tonsil, anterior wall of the pharynx, and fauces.[29,30]

INCIDENCE

Cancer of the tongue and floor of the mouth is the most frequent intra-oral malignancy. Approximately 200 individuals in each million develop carcinoma in this location every year. Unless early diagnosis is established and adequate treatment administered, these patients suffer horrible deaths. The largest incidence occurs during the sixth decade. Men are affected more frequently than women in a ratio of 5 to 1. Recently 2 cases of carcinoma of the tongue were observed in patients under 30 years of age in which the cancers had been permitted to grow extensively and metastasize to the lymph nodes of the neck. Both cases had been treated elsewhere for syphilis because of a positive serologic test for syphilis with no consideration given to a large indurated ulcer on the tongue and enlarged lymph nodes in the drainage area. Martin and coworkers,[19,20] reporting from the Memorial Hospital in New York, state that cancer of the tongue and floor of the mouth comprises approximately 15 per cent of all cancers in the upper respiratory and alimentary tracts and that cancer of the tongue accounts for approximately 3 per cent of all human cancer.

ANATOMY AND HISTOLOGY

A resumé of the anatomy of the tongue shows that the anterior two-thirds, that is, from the anterior pillar and circumvallate papillae forward, arises from the first and second branchial arches and is covered with ectoderm, whereas the posterior third or root arises from the third and fourth arches which, with the mucous membrane covering, has its origin from entoderm. Consequently, tumors arising in the anterior two-thirds, as a rule, are well differentiated squamous cell carcinomas which comprise the greater percentage of intra-oral malignancies,[26] whereas those arising from the posterior third are less well differentiated, more anaplastic, metastasize earlier and are more sensitive to irradiation therapy. The

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adenocarcinomas, which comprise approximately 5 per cent of the total intra-oral carcinomas, have origin in the embryonic epithelium destined to form salivary or mucous glands; hence this group of cancers may be encountered in any place in the mouth where mucous glands or salivary tissue is found. They are more frequently located on the soft and hard palates or along the lateral posterior surface of the tongue. The author has had several cases with local recurrences and cervical metastases which developed after removal of mixed salivary tissue tumors.

Treatment of Carcinoma of Tongue and Floor of Mouth

Formerly carcinoma of the tongue and floor of the mouth was treated by some therapists with implantation of radium needles, intra-oral molds containing radium tubes, teleradium externally, or roentgenotherapy in conjunction with intra-oral radium. This plan of therapy was used in an attempt to eradicate the primary cancer and as a prophylactic measure to sterilize lymph nodes in the drainage area or metastasis, if present. When given in sufficient quantities to eradicate squamous cell carcinoma or adenocarcinoma in these areas, this form of therapy produces, in a substantial percentage of cases, permanent changes in the surrounding normal structures, such as obliterating endarteritis, sclerosis and later a breakdown of the tissues with a painful ulcer which may occur months or years later. Due to the constant presence of bacterial flora and pooling of saliva in the mouth, radiation ulcers become covered with a necrotic slough and seldom heal even with good oral hygiene. Such ulcers frequently extend to involve the deep tissues of the floor of the mouth and tongue and to erode the lingual artery and vein or their terminal branches resulting in severe hemorrhage. In addition, intense pain is present which is difficult to control. Radio-osteonecrosis produced by obstruction of the capillary blood supply is a frequent complication following radium therapy in any form. When bone is exposed in a necrotic ulcer or when teeth (which have not been removed before radium therapy is administered) are extracted, infection and osteomyelitis may develop. Martin and co-workers [20] report that 25 per cent of their patients developed osteomyelitis following radium treatment of primary cancers of the tongue and floor of the mouth.

Baud,[1] reporting from the Curie Foundation in Paris, found that 3.6 per cent of a series of cases treated with radium therapy died of complications resulting from this mode of treatment, i.e., dysphasia, cervical abscess from radium needle puncture, hemorrhage, cachexia, intensive mucous reaction, and sclerotic edema.

When radium puncture therapy is employed with the use of radium needles, the floor of the mouth and tongue in the region of the submaxillary duct may become inflamed with a resultant obstruction, infection, and suppuration of the submaxillary gland. This swelling may simulate metastasis or metastasis may be present, making a differential diagnosis difficult. In addition, the infection increases virulence of the cancer in the lymph nodes.

Baud,[1] Berven[2] and Cade[6] report that 25 per cent of carcinomas of the tongue and floor of the mouth treated with radium in its various forms persist or recur, becoming more difficult to control with any modality of therapy. A careful review of the literature reveals that clinics in this country,[23,30] as well as in England,[3] France[1] and the Scandinavian countries which formerly attempted to eradicate the local cancer of the tongue and floor of the mouth by either intra-oral or a combination of intra- and extra-oral radium therapy no longer attempt to control metastases, if present, by irradiation therapy in any form due to the poor results and numerous complications resulting, but now advocate radical neck dissections to take care of metastases in the drainage area.

Ward[28] appreciated this problem as early as 1932 when he resected the primary growth, surrounding tissue, jaw and lymph node bearing tissue en bloc in a case of carcinoma of the left lower gingiva with cervical metastasis. The patient, an elderly man, made a good convalescence and had no recurrence after two years. Ward also was cognizant of the frequency of involvement of the mandible in cancer of the tongue and floor of the mouth and, at his suggestion, Robben[28] made a careful study of the anatomy and pathology of the clinical extension of cancer of the tongue and floor of the mouth. In reviewing the literature, Robben found that Polya, in 1902, published a careful anatomical study of the lymphatics of the head and neck which was later confirmed by other anatomists. These reports showed that in 50 per cent of normal individuals the lymphatics of the tongue and floor of the mouth pass through the periosteum of the mandible on their way to the lymph nodes in the submaxillary triangle. This fact explained Ward's observation of the frequency of early attachment of metastases from the primary growth to the mandible and emphasized the need for resection of the horizontal ramus of the mandible. Morrow[22] reports that, even though lymph nodes are not clinically involved in cancer of the tongue, metastases are present in 39 per cent of cases and when the lymph nodes are clinically involved, metastases are present in 52 per cent.

It is our policy at this time to utilize preoperative roentgeno-

therapy to the primary lesion on the tongue or floor of the mouth, followed by hemiglossectomy and radical neck dissection en bloc, the composite operation described later, in preference to roentgenotherapy or surgery alone for the following reasons: In any large series of cases a substantial percentage of patients will have rather advanced cancers on admission and the tumors are still active in their growth with the lymphatics already invaded or being invaded. Irradiation therapy destroys a considerable number of the primary cancers, devitalizes and shrinks the larger ones sufficiently to permit their surgical removal with less likelihood of recurrence. Twenty-one and four tenths per cent of a series of cases previously reported showed lingering cancer cells after the primary growth was given 6,000 to 10,000 roentgens tumor dose.[28] Roentgenotherapy given in sufficient quantities to eradicate squamous cell carcinoma or adenocarcinoma frequently produces permanent tissue changes in the treated area with a later breakdown of the tissues. This complication is exceedingly painful, incapacitating and produces emaciation due to the inability of the patient to take adequate food.

Exceptions to the use of preoperative roentgenotherapy and the composite operation en bloc for eradication of carcinoma of the tongue and floor of the mouth are:

1. Small papillary carcinomas on the tip of the tongue are surgically excised by a V-shaped excision. These carcinomas metastasize slowly, do not infiltrate the submucosa or muscular coat early and therefore good results are obtained by this method of treatment.

2. Early growths on the floor of the mouth, especially in the anterior third just beneath the tip of the tongue may be surgically excised with electrosurgery, producing no deformity of note. The excision is extended on to the mucous membrane of the tongue and the periosteum of the buccal surface of the mandible is removed with the tumor.

3. Lesions occurring in debilitated patients who are poor operative risks.

4. Small early growths of low histologic grades and without palpable lymph nodes in the drainage area which respond to adequate roentgenotherapy.

5. Patients who refuse surgery.

Patients in all these groups must be observed at regular intervals for metastases or recurrence.

Before irradiation therapy is begun all teeth in the area to be treated and all infected or ragged teeth are removed. Teeth in

good condition located in the front of the jaw which may interfere with accurate application of roentgenotherapy are cut off just above the gums and rebuilt upon completion of roentgenotherapy and surgery. The dentist meticulously cleans the remaining teeth and strict attention is paid to oral hygiene before and during the roentgen treatment. An alkaline saline mouth wash containing one teaspoon each of sodium chloride and sodium bicarbonate in one quart of water is used.[19] If there is extensive local ulceration, it is well to use Dakin's solution and administer antibiotics which will prevent the patient from developing a painful glossitis resulting from inadequate diet and vitamins. Sufficient quantities of Vitamins B and C are given while roentgenotherapy is being administered.

Treatment factors are:

140 KVP, 8 ma, ¼ Cu plus 1 Al filter, 24 cm. TSD with a cone of sufficient size to adequately cover the lesion. From 400 to 500 roentgens are given three times a week so the total dose is 6,000 roentgens given within a period of three to four weeks.

This does destroy most cancers on the tongue and floor of the mouth under 3 cm. in diameter.

Larger tumors in the posterior third of the tongue may require radon seed implantation in addition, bringing the total intratumoral dose to the desired amount. In very large lesions, in addition to intra-oral roentgenotherapy, penetrating roentgenotherapy may be used through the skin. If the tumor is in the anterior part of the floor of the mouth or tongue a submental port of suitable size is employed. When the tumor is located in the posterior third of the tongue, one portal may be utilized on the involved side through the mandibular area and a second on the opposite side. This permits sealing of the lymphatics immediately. In these cases, the intra-oral dose is reduced to 3,000 to 4,000 roentgens with the above technic and the two mandibular ports receive approximately 2,000 roentgens each with the following treatment factors:

260 KVP, 18 ma, Thoraeus filter equivalent to 1 mm. Cu, 50 cm, TSD with appropriate size ports. The extra-oral ports receive 200 to 300 roentgens three times a week alternating with the intra-oral treatment.

Extra-oral roentgenotherapy is only utilized in a select group of patients with thick healthy skin if the primary lesion occurs anterior to the pillars on the tongue or floor of the mouth. Preoperative irradiation therapy through the skin has been found unwise if the cancer involves the tonsil, pharyngeal wall, or the area in front of the pillars.

During the past several years block neck dissections have been utilized by some surgeons[1,2,6,7,30] to remove lymph nodes in the

drainage area, whether they are involved or not, after the primary growth has been thoroughly sterilized by irradiation therapy. On the other hand, others[21] prefer to wait until the lymph nodes are definitely involved before neck dissection is utilized which seems as useless as permitting axillary lymph nodes to become involved in carcinoma of the breast before their removal is undertaken. Slaughter[25] reports a combined surgical procedure for removal of intra-oral cancer and involved cervical lymph nodes en masse. Sugarbaker and Gilford[26] also describe a procedure for combined jaw and neck dissection for carcinoma of the lower gingiva and involved cervical lymph nodes.

Operative Technic: The composite operation[28,29] includes removal of the lymph node-bearing tissue from the clavicle to and including a hemiglossectomy, floor of the mouth, and a segment of the mandible. It is especially useful in cancers of the floor of the mouth, lower gingiva, tonsil, faucial pillars, lateral pharyngeal wall, and tongue except the anterior tip. The operative procedure is usually performed four to six weeks after completion of the irradiation therapy and is carried out in two stages spaced two to three weeks apart.

The first step of the procedure is carried out under local anesthesia[28] and consists of preparing an epithelial lined flap for better reconstruction of the floor of the mouth. This procedure prevents scar tissue which causes disfigurement, fixation of the tongue, difficulty in mastication, swallowing, and talking. Two types of flaps have been utilized: the first is prepared by making a curved incision from the midline of the chin to the mastoid process, extending the convexity at least below the hyoid bone about two-thirds down the neck (fig. 1-a). From the middle of this incision a second vertical one is extended down to the middle of the clavicle. The upper flap is raised as illustrated and a split-thickness graft, taken from the thigh with a Brown Electrodermatome, is applied to the undersurface of the upper flap and sutured with fine chromic catgut. The incisions are closed and the flap is sutured back in place. The second type of flap may be prepared by raising a long vertical neck flap with a pedicle at the upper end. The lower end is turned under to form a full thickness apron which eventually becomes the floor of the mouth. A rubber tissue drain is placed through the lower end of the apron which forces circulation through its upper end (fig 1-b). In the apron type flap a split-thickness graft is taken from the side of the thigh to cover the raw surface on the side of the neck from which the apron flap was raised.

Intratracheal anesthesia is the anesthetic of choice for the second

stage of the surgical procedure after introduction with pentothal sodium intravenously. A tracheostomy has been found necessary to reduce postoperative morbidity and mortality in all composite opera-

Fig. 1-a. Modified Kocher incision for radical neck dissection. Skin flaps are dissected back on all sides. Skin opened down to platysma muscle; split-thickness graft applied to under surface of upper flap and sutured with fine chromic catgut to form new lining for oral cavity.

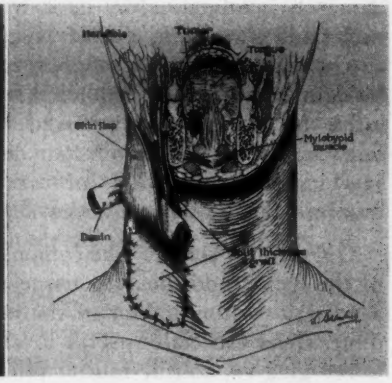

Fig. 1-b. Schematic drawing showing development of apron flap by turning flap on itself. Split-thickness graft used to cover raw surface on neck. Cigarette drain placed between two leaves of apron flap aid in forcing circulation through distal end which will form lining of floor of mouth.

tions and this is carried out at the beginning of the second stage of the operative procedure under pentothal anesthesia. The endotracheal tube is then placed in the tracheostomy and anesthesia is continued with pentothal sodium, nitrous-oxide, oxygen and curare, if indicated. This permits electrosurgery to be used safely for dissection or coagulation. Explosive mixtures are contraindicated. The nasopharynx is packed off with a moist pack. If necessary, it is possible to operate four or five hours with the use of this anesthesia. By performing a tracheostomy sudden postoperative deaths from laryngeal obstruction may be eliminated. Also, when there is marked infection in the pterygoid fossa, the trachea may be aspirated preventing pulmonary complications. The tracheostomy tube is removed after five or six days following the surgical procedure.

Neck Dissection: The type of skin flap prepared in the above procedure will determine how the neck will be opened in the second stage of the operation. If a split-thickness lined graft has been prepared, the previous incisions are opened, or if an apron flap has been used, the split-thickness graft applied at the first operation is removed with the specimen. The skin flaps are dissected widely on all sides to permit a radical neck dissection to be carried out. The split-thickness lined flap is elevated without injury to the graft or if

the apron flap is utilized, it is turned up over the neck. The platysma muscle remains attached to the skin to permit better circulation unless there is close attachment of the metastases to it. The dissection is carried upward, including the sternomastoid and omohyoid muscles, jugular vein (internal), and all lymph-bearing tissue. The sternomastoid muscle is severed at its attachment to the clavicle and the lower end is ligated with chromic catgut sutures. The jugular vein is ligated with medium silk and severed between the sutures (fig. 2). The omohyoid muscle is severed and the dissection is carried upward, removing all tissue between the strap muscles anteriorly and trapezius posteriorly. The common carotid artery, vagus and phrenic nerves are carefully protected. If there is evidence the spinal accessory nerve is involved by metastatic tumor, it is removed en bloc with the lymph node-bearing tissue. The external carotid artery and/or its branches are doubly ligated and severed to reduce hemorrhage. The posterior bellies of the digastric and stylohyoid muscles are identified but not removed if not involved by the tumor. If they are involved, they are removed. The ligaments are severed at the attachment to the hyoid bone and retracted

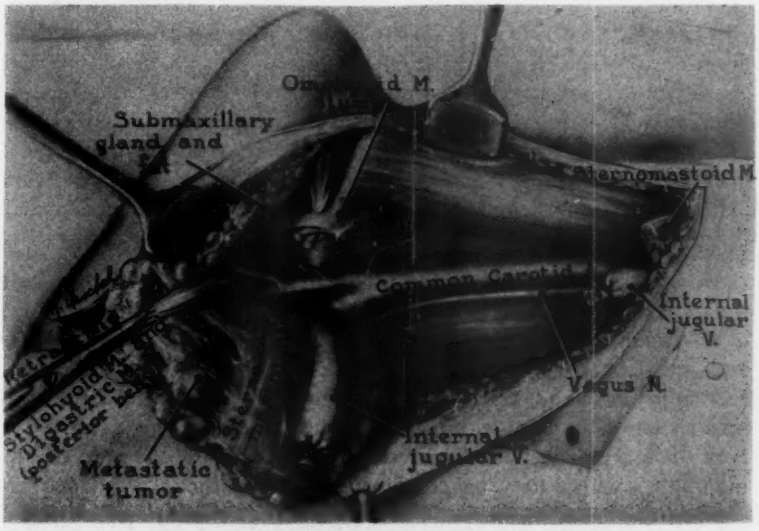

Fig. 2. Neck dissection from clavicle to mandible, from strap muscles in front to trapezius posteriorly.

posteriorly, exposing the jugular vein and the carotid sheath to the base of the skull. Frequently metastases are present in this location, especially when the growth is in the posterior area of the mouth. If the muscles are not involved, they may be saved and resutured

at the termination of the procedure to cover the internal carotid artery. If there is any doubt about the location of the jugular vein and carotid artery in the upper area of the neck, the digastric muscle serves as a guide as these vessels lie beneath it.

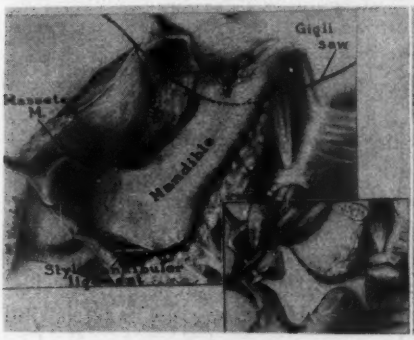

Fig. 3-a. Method of removing segment of mandible with Gigli saw. Insert shows disarticulation of mandible.

Fig. 3-b. Tongue muscles are being severed from hyoid bone.

The resection is extended up to the midline in front along the anterior belly of the digastric muscle which is preserved with the geniohyoid if not involved, to support the hyoid bone. The dissection is extended posteriorly to the anterior border of the trapezius muscle and all lymph node bearing tissue is removed with the sternomastoid muscle which is severed from its attachment to the mastoid process. The internal jugular vein is ligated with medium silk near the base of the skull and severed.

Resection of the Jaw: When the disease is limited to the floor of the mouth or middle third of the tongue, only the horizontal ramus of the mandible is removed. By removal of the horizontal ramus and, if necessary, the entire mandible on the involved side, an accurate approach is made to growths which are far back on the posterior part of the tongue, pharyngeal wall, pillar or tonsil (fig. 3-a). Any disfigurement caused by loss of a portion of one side of the mandible (which may be corrected by a prosthetic appliance) is compensated for by a much higher curability obtained by more radical operation of the primary cancer and lymph node bearing tissue.

Dissection of the Tongue Muscles: This phase of the dissection is of importance when there is extension of the tumor with invasion of the floor of the mouth and tongue muscles. The mylohyoid muscle is severed at its attachment to the hyoid bone; the genioglos-

sus muscle is severed from its attachment to the genial tubercle and the hyoid bone, and the hyoglossus muscle, if involved, is severed from the hyoid bone to give a better exposure of the field and a wider margin of safety. The mouth is opened by an incision through the buccal mucosa extending the incision as far posteriorly as necessary to adequately expose the oral cavity and pharynx (fig. 3-b). The tongue is pulled forward by two traction sutures, and severed through the midline with an electrosurgical scalpel. The excision is extended posteriorly 2 cm. beyond the indurated area of the growth. If the disease does not involve the tonsil pillar but remains confined to the tongue and floor of the mouth or mandible, the line of excision is established more anteriorly leaving the pharyngeal wall, palate, tonsil and its pillars intact.

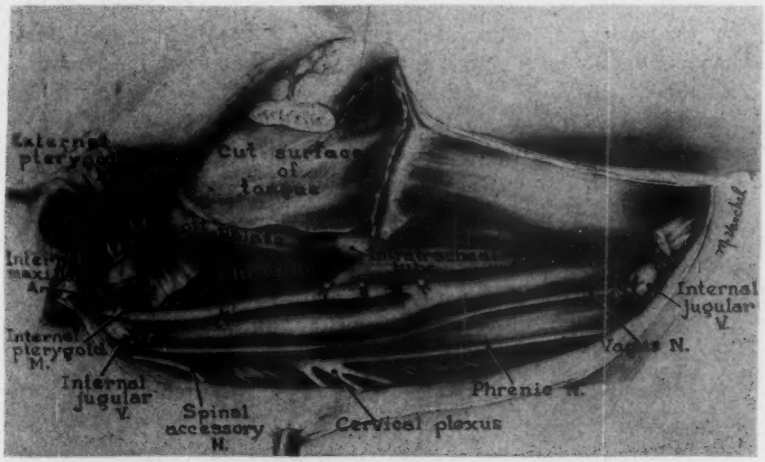

Fig. 4. A section of mandible has been removed; oral cavity is open; tongue has been severed through the midline with electrosurgical scalpel; external carotid artery has been ligated. Tumor involving tongue, floor of the mouth and mandible with all node-bearing tissue of neck has been removed. Illustration demonstrates wide excision which this operative technic permits. Tumors involving pterygoid muscles and fossa may be readily excised.

In cases where the growth involves the tonsil pillar and lateral pharyngeal wall, the stylohyoid, styloglossus and stylopharyngeus muscles and the stylomandibular ligament are severed from the styloid process. The internal maxillary artery and vein are ligated and severed. If the internal and external pterygoid muscles are involved by tumor, these are removed or destroyed with electrocoagulation (fig. 4). The pharyngeal mucosa is severed in the horizontal plane at a safe level and as much of the soft palate as necessary is removed above the growth. The pharyngeal mucosa is

excised vertically to meet the incision previously made in the midline of the tongue which permits removal of the entire specimen en masse. Hemostasis is effected with either ligature or electrocoagulation.

Closure: It is important to close the lower neck wound tightly below the hyoid bone before the mouth is entered to prevent its contamination with saliva. Rows of interrupted sutures of black silk tack the upper margin of the lower skin flaps to the remaining fascia and muscles. Any rent in the pharyngeal wall is closed with fine chromic catgut if possible; otherwise, it heals by cicatrization. The split-thickness graft or the inner half of the apron flap with the skin side up is sutured to the raw surface of the base of the tongue and the oral mucous membrane with subcuticular or submucous sutures of fine chromic catgut, creating a new floor for the mouth. The pedicle flap or outer half of the apron flap is brought as far down as possible on the neck and sutured to the lower flap, and any remaining raw surface is covered with a split-thickness graft. When it is advisable to resect only an area of the horizontal ramus of the mandible, it may be reconstructed by insertion of a steel bar between the stumps to hold the mandible in normal position. This bar fastens between the two layers of the full-thickness skin graft in the flap. When it is determined preoperatively that a wide area of mandible will be removed and the ascending ramus disarticulated, a bar plane prosthesis which fastens to teeth on the uninvolved side of the mandible is inserted at the time of operation to maintain proper alignment of the mandibular fragments.

Postoperatively, there may be some leakage or a temporary fistula may develop where the split-thickness graft or apron flap was sutured to the tongue but these are small and will close themselves.

Discussion

The composite operation is the most practical method of eradicating cancer of the floor of the mouth, tongue, and more advanced cancers of the lower gingiva. It permits removal of the site of malignancy, avenues of extension, and node-bearing tissue en bloc (fig. 5-a,b,c). Anatomical landmarks, i.e., blood vessels, nerves and other structures are visualized and preserved or removed as the case at hand necessitates.

Since most advanced malignancies of the floor of the mouth, tongue and lower gingiva involve the mandible, the jaw is removed with the specimen, the latter to permit a removal of cancers of the posterior third of the tongue with extension on to anterior pillar, tonsil, lateral pharyngeal wall, or into the pterygoid muscle and

Fig. 5-a and b. Carcinoma of floor of the mouth with metastasis to lymph nodes in submaxillary gland. Intra-oral roentgenotherapy, 6,000 r, and extra-oral irradiation to both submandibular areas, 2,000 r. Six weeks later composite operation performed using apron type flap to form floor of mouth.

Fig. 5-c. View of patient 24 months after composite operation; patient is edentulous and has difficulty wearing any type of prosthesis on resected side of mandible but has good functional results with ability to take adequate nutrition and follow his occupation.

Fig. 6-a. Guide plane type of prosthesis placed on involved side of mandible prevents mandibular fragment from being pulled over by scar tissue immediately following resection.

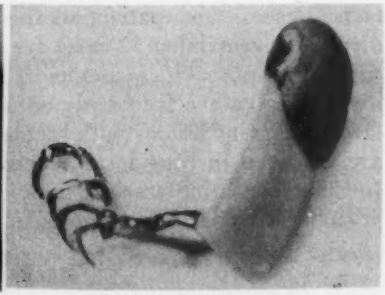

Fig. 6-b. Prosthesis attached to teeth on uninvolved side gives fullness to resected side of mandible. Prosthesis may carry teeth.

Figures 1 A, B; 2; 3 A, B; 4; 6 A, B; from Ward and Hendrick: *Tumors of the Head and Neck.* Williams and Wilkins Company, 1950.

fossa. Modern prosthetic appliances permit removal of a segment of mandible or maxilla with good cosmetic results and allow the patient to return to his former occupation (fig. 6-a,b). The last 5 patients who underwent this surgical procedure have returned to their respective occupations as school teacher, radio announcer, office manager in a large establishment, foreman of a construction crew, and foreign representative of a major oil company.

Recent advances in anesthesia, fluid balance, adequate blood from a blood bank, surgical technic, the free use of antibiotics, intranasal feeding during intensive preoperative roentgenotherapy, and postoperative convalescence permit extensive operative procedures in the region of the head and neck to be carried out with minimum mortality and rapid convalescence.

This operative procedure was developed and has been utilized with very commendable results. The morbidity and mortality rates have been low in cases of malignancies which heretofore have been difficult to control.

Contraindications to the composite operation are: tumors which extend past the midline, cancers which are practically frozen to the tongue, floor of the mouth and extending on to the mandible and submaxillary areas which are nonresponsive to adequate irradiation therapy, and cases showing evidence of metastases below the clavicle.

SUMMARY

Sufficient time has not elapsed to permit a five year evaluation of patients, some of whom had uncontrolled tumors and were formerly considered inoperable. No mortality has been encountered in the last 53 cases. One patient of this group had persistent tumor and died. The remaining 52 cases are clinically free from disease at this time. Patients with carcinoma of the tongue, floor of the mouth, or lower gingiva are frequently encountered with advanced lesions or large recurrent lesions with metastases to the lymph drainage area are salvaged in considerable numbers by this procedure. By performing a routine tracheostomy, respiratory complications in the postoperative period are not encountered.

REFERENCES

1. Baud, J.: End results of radium therapy in cancer of tongue, Am. J. Roentgenol. *63*:701 (May) 1950.
2. Berven, E.: Results of treatment of cancer of tongue, Am. J. Roentgenol. *63*:712 (May) 1950.
3. Brown, J. B., and Haffner, H.: Lesions of tongue: collective review, Internat. Abstr. Surg. *69*:119, in Surg., Gynec. & Obst. (Aug.) 1939.
4. Butlin, H. T.: Diseases of the Tongue, Philadelphia, Lea Brothers & Company, 1885.

5. Butlin, H. T. (ed. by Spencer, W. G., and Cade, S.): Diseases of the Tongue, ed. 3, London, H. K. Lewis and Company, Ltd.; Philadelphia, T. Blakiston Sons and Company, 1931.
6. Cade, S.: Radiation treatment of cancer of mouth and pharynx, Lancet *2:*4 (July 1) 1933.
7. Cade, S.: Treatment of cancer of tongue, Am. J. Roentgenol. *63:*716 (May) 1950.
8. Carr, M. W.: Squamous cell carcinoma of tongue as sequel to leukoplakia, J. Oral Surg. *6:*78, 1948.
9. Crile, G. W.: Treatment of malignancy, Ann. Surg. *93:*99 (Jan.) 1931.
10. Edgerton, M. T.: Replacement of lining to oral cavity following surgery, Cancer *4:*110 (Jan.) 1951.
11. Halsted, W. S.: Results of operations for cure of cancer of breast performed at Johns Hopkins Hospital from 1889 to January 1894, Bull. Johns Hopkins Hosp. *6:*297, 1894-95.
12. Horrax, G., and Poppen, J. L.: Trigeminal neuralgia, Surg., Gynec. & Obst. *61:*394 (Sept.) 1935.
13. Hendrick, J. W.: Differential diagnosis of neck tumors, South. M. J., October 1952.
14. Hendrick, J. W., and Ward, G. E.: Treatment of cancer of lip, J. Internat. Coll. Surgeons *15:*7 (Jan.) 1951.
15. Hendrick, J. W.; Ward, G. E., and Lacy, M. M.: Salivary tissue neoplasms, Am. J. Surg. *81:*373 (April) 1951.
16. Jorstad, L. H., and Verda, D. J.: Cancer of tongue: its diagnosis and treatment, S. Clin. North America *24:*1077 (Oct.) 1944.
17. Lawrence, E. A., and Brezina, P. S.: Carcinoma of oral cavity, J.A.M.A. *128:*1012 (Aug. 4) 1945.
18. Livingston, E. M., and Lieber, H.: Surgical aspects of treatment of carcinoma of tongue, Am. J. Surg. *30:*234 (Nov.) 1935.
19. Martin, H. E.; Munster, H., and Sugarbaker, E. L.: Cancer of tongue, Arch. Surg. *41:*888 (Oct.) 1940.
20. Martin, H. E., and Sugarbaker, E. L.: Cancer of floor of mouth, Surg., Gynec. & Obst. *71:*347 (Sept.) 1940.
21. Martin, H. E.; Del Valle, B.; Ehrlich, H., and Cohan, W. G.: Neck dissection, Cancer *4:*441 (May) 1951.
22. Morrow, A. S.: Cancer of tongue, Ann. Surg. *105:*418 (March) 1937.
23. Paterson, R.: Cancer of mouth, Postgrad. M. J. *17:*89 (June) 1941.
24. Pyott, J. E.; Bruder, V. F. J.; Manion, W. J., and Ward, G. E.: Leaded resinous applicators for intra-oral and extra-oral radium therapy, Am. J. Roentgenol. *47:*613 (April) 1942.
25. Slaughter, D. P.: Neck dissection, indications and technics, S. Clin. North America *26:*102 (Feb.) 1946.
26. Sugarbaker, E. D., and Gilford, J.: Combined jaw resection and neck dissection for métastatic carcinoma of cervical lymph nodes, secondarily involving mandible, Surg., Gynec. & Obst. *83:*767 (Dec.) 1946.
27. Ward, G. E., and Duff, A. M., Jr.: Tumors of the Tongue, in Cyclopedia of Medicine, Philadelphia, F. A. Davis Company, 1940, vol. 15, p. 174.
28. Ward, G. E., and Robben, J. O.: Composite operation for radical neck dissection and removal of cancer of tongue, Cancer *4:*98 (Jan.) 1951.
29. Ward, G. E., and Hendrick, J. W.: Diagnosis and Treatment of Tumors of Head and Neck, Baltimore, Williams and Wilkins Company, 1950.
30. Ward, G. E., and Hendrick, J. W.: Tumors of jaws, J. Internat. Coll. Surgeons *15:*443 (April) 1951.
31. Windeyer, B. E.: End results and treatment of cancer of tongue, Am. J. Roentgenol. *63:*719 (May) 1950.

ACUTE MASSIVE VENOUS THROMBOSIS OF THE LOWER EXTREMITY (PHLEGMASIA CERULEA DOLENS)

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PHLEGMASIA cerulea dolens (blue thrombophlebitis) occurs much less frequently than phlegmasia alba dolens (milk leg). Approximately 60 such cases have been recorded in the literature.[4] The exact cause of this condition is not well understood, but in the majority of cases there is some predisposing factor such as surgery, delivery, abortion, trauma, ligation of a major venous channel, injection of a sclerosing solution, malignancy, or infection.[1,2,7,8]

The clinical picture is characterized by a sudden onset of severe pain, venous congestion, cyanosis, edema, and circulatory failure in one of the extremities.[1,2,8] In approximately two-thirds of the cases the distal arteries are not palpable because of arterial spasm and edema.[2] Arterial embolism is closely simulated in some instances.[1,2] According to Haimovici, 56 per cent of cases manifest themselves in this fashion, while 44 per cent begin as the more familiar phlegmasia alba dolens and subsequently develop symptoms and signs which simulate arterial occlusion.[2] According to a report by DeBakey and Ochsner, gangrene developed in 43 per cent of cases, pulmonary embolism occurred in 10 per cent, and approximately 33 per cent ended in death.[1] The lower extremities are affected four times as frequently as the upper.[1] Clinical shock has been observed in some cases, and is apparently due to the fact that considerable blood is suddenly trapped within an extremity and thus removed from the general circulation.[5] Veal believes that the loss of considerable fluid into the tissue spaces is the cause of shock.[8] Severe pain may be a contributing factor.

Examination of autopsy and surgical specimens in these cases reveals patent arteries and extensive thrombosis of all veins in the affected extremity. Phlebitis and periphlebitis are present. Gangrene appears to be the result of complete blocking of the venous circulation and superimposed arterial spasm.[1,2,3,6,7,8]

The majority of these cases can be successfully managed by conservative methods. According to Veal the most important therapeutic measure consists of elevation and exercise of the affected extremity in order to mechanically express the venous blood from

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the limb.[8] Novocain injections of the lumbar sympathetic nerves and ganglia and vasodilator drugs are of limited value.[1,2,6,8] Frequent administration of morphine is necessary for relief of pain. A dramatic recovery following ligation of the inferior vena cava has been reported by Miles.[4] The use of anticoagulants to prevent progression of the thrombosis is helpful. Gangrene is often superficial and frequently limited to the toes and heel. For this reason amputations should be conservative and delayed as long as possible.[1,2,3] Transfusions of whole blood or plasma should be given immediately in those cases in which shock is present.

Case Report

R. C., a white man 24 years of age, underwent a partial gastrectomy for an intractable duodenal ulcer March 27, 1951. On the sixth postoperative day he first noticed pain in the left inguinal region. In less than four hours the pain had become quite severe. Edema of the thigh and calf developed rapidly. The entire limb appeared mottled and cyanotic. The foot was cold and pulseless. It was our impression that he was suffering from acute thrombophlebitis, although the severity of the peripheral ischemia suggested arterial embolism. The left lumbar sympathetic ganglia were injected with procaine on three occasions during the first 24 hours. After each injection the foot became slightly warmer and pain was diminished temporarily, but the improvement was not as dramatic as had been hoped for. The limb was elevated and active exercise without weight bearing was encouraged. He was obviously acutely ill and required frequent hypodermic injections of morphine for relief of pain. The oral temperature ranged from 100 to 102 F. and the pulse rate varied from 100 to 120 beats per minute.

On the ninth day following operation he experienced sudden, agonizing pain in the epigastrium. He was covered with cold perspiration. Vomiting occurred soon after the onset. The pulse was rapid and thready. The blood pressure was 90/60. Rather marked rigidity of the abdominal musculature was present. It appeared that an acute abdominal catastrophe had occurred. Leakage of the duodenal stump, mesenteric thrombosis, and acute pancreatitis were considered to be the most likely diagnoses. The serum amylase was 111 mg. per 100 cc., hemoglobin 13 Gm. per 100 cc., leukocyte count was 13,000 per cu. mm. He was given penicillin, streptomycin, continuous gastric suction, glucose and procaine by the intravenous route, warm moist applications, elevation, and exercise of the affected extremity. The following day the serum amylase was 192 mg. per 100 cc. He appeared semicomatose, but continued to complain bitterly of pain.

On the eleventh day the pain in the left lower extremity was even more severe and pulsations in the femoral artery were now scarcely palpable. The limb was very swollen and cyanotic. He was given 300 mg. of depo-heparin as the initial dose and 200 mg. daily thereafter.

On the fourteenth day, the limb was noticeably warmer and pulsations in the femoral artery were stronger. On the sixteenth day the pain was less intense and the edema appeared to be subsiding. Depo-heparin was discontinued.

On the twenty-first day a superficial wound abscess containing approxi-

mately one ounce of purulent fluid was incised and drained. On the same day the patient complained of a little pain and tenderness over the right femoral vessels. The following day there was a profuse drainage of duodenal fluid from the operative wound. A catheter was inserted into the opening and connected to a Stedman pump. The skin was protected with vaseline gauze and aluminum paint. Whole blood transfusions and oral potassium chloride were administered.

On the twenty-third day there was pain, swelling, and tenderness of the right lower extremity, involving the femoral and popliteal vessels and calf. Depo-heparin in the dosage previously employed was again administered. The following day there was less drainage from the duodenal fistula. Both lower extremities were subjectively and objectively improved. Heparin was discontinued.

On the twenty-seventh day there was almost no drainage from the fistula. On the twenty-ninth day he was afebrile and steadily improving. By the thirty-fifth day drainage from the fistula had ceased. Swelling and cyanosis of the left foot were now apparent only when the foot was allowed to hang down. He was discharged from the hospital 39 days following operation with instructions to wear elastic bandages from the toes to the groin whenever walking or standing. He was last seen on July 6, 1951, at which time he was still having slight swelling of the left leg and foot.

SUMMARY

The clinical manifestations, pathology, and treatment of an unusual type of thrombophlebitis are discussed. A report of a case occurring in the early postoperative period which was successfully managed by conservative measures is presented.

REFERENCES

1. DeBakey, M. E., and Ochsner, A.: Phlegmasia cerulea dolens and gangrene associated with thrombophlebitis; case reports and review of literature, Surgery *26:* 16 (July) 1949.
2. Haimovici, H.: Gangrene of extremities of venous origin; review of the literature with case reports, Circulation *1:*225 (Feb.) 1950.
3. Haimovici, H., and Suffness, G.: Gangrene of extremities of venous origin; report of case, Am. J. M. Sc. *215:*278 (March) 1948.
4. Miles, R. M.: Phlegmasia cerulea dolens—successful treatment by vena cava ligation; case report, Surgery *30:*718 (Oct.) 1951.
5. Morgan, E. H.; Allen, E. V., and MacCarty, C. S.: Acute peripheral circulatory failure caused by acute venous thrombosis, Proc. Staff Meet., Mayo Clin. *23:*425 (Sept. 15) 1948.
6. Ochsner, A., and DeBakey, M.: Thrombophlebitis; role of vasospasm in production of clinical manifestations, J.A.M.A. *114:*117 (Jan. 13) 1940.
7. Tilley, J. H.: Gangrene of extremities in puerperal thrombophlebitis, Am. J. Obst. & Gynec. *36:*157 (July) 1938.
8. Veal, J. R., et al.: Acute massive venous occlusion of lower extremities, Surgery *29:*355 (March) 1951.

POTASSIUM DEFICIENCY AND HYPOCHLOREMIC ALKALOSIS IN THE POSTOPERATIVE PATIENT

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THE problem of maintaining fluid and electrolyte balance in the postoperative patient has received increasing attention during recent years. Much knowledge has been gained, and a scientific approach has replaced the trial and error method in determining the fluid requirement and the quantity of sodium chloride and other electrolytes necessary to maintain the proper chemical balance in the postsurgical patient. The importance of individualizing the patient has been emphasized. The danger of overloading the circulation of the aged patient with cardiovascular impairment must be guarded against by giving relatively small amounts of fluid, while the patient losing large quantities of fluid by gastric suction or diarrhea must receive a large volume of fluid for replacement. Thus, one patient may require as little as 2,000 cc. while another may require as much as 8,000 to 10,000 cc. of fluid in a 24 hour period.

Prevention and correction of electrolyte imbalance follows a similar pattern. The inadvisability of administering large quantities of sodium chloride solution intravenously without knowledge of the patient's salt loss is now generally appreciated. Similarly, care should be exercised to prevent sodium chloride depletion by administration of adequate quantities of salt to the patient losing large amounts by gastric aspiration or vomiting.

Alteration in the sodium and chloride balance may be associated with significant changes in the distribution of other ions which may be sufficient to produce chemical imbalances giving rise to certain definite and recognizable clinical syndromes. The syndrome of potassium deficiency and hypochloremic alkalosis arising under such circumstances forms the bases for discussion in this paper.

This syndrome has been recognized only in recent years, and the surgical literature contains increasing reference to it during the past five years. The rather characteristic clinical feature of the syndrome, including etiologic factors, symptoms, diagnosis, and methods of treatment, have been described. Recognition of the syndrome has resulted in salvage of a considerable number of patients formerly lost without an understanding as to the cause of their deaths.

Etiology. Various factors influence the development of a po-

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tassium deficiency state following surgery. Perhaps the most important of these are decreased intake of potassium and excessive loss of potassium through the gastrointestinal tract. The normal daily intake of potassium for an adult is about 3 to 4 Gm. or 75 to 100 mEq.[2] The patient unable to take food by mouth and requiring continuous gastric suction is deprived of this intake and also loses large quantities of potassium ions in the gastric juice and bile aspirated from the stomach. Gastric juice contains approximately 8 mEq. of potassium per liter, and hepatic bile about 4.5 mEq. per liter. Due to concentration, the potassium content of gallbladder bile is almost twice that of liver bile. Large amounts of potassium may also be lost from the gastrointestinal tract through drainage from an enterostomy or as a result of a diarrhea. Continued excretion of potassium, even in the face of diminished or absent intake, is further responsible for deficiency of this substance. Tarail and Elkinton[10] found that an adult on a potassium-free diet excreted 40 to 50 mEq. per liter of potassium per 24 hours. The renal threshold for potassium is low and large amounts of it may be lost in the urine if diuresis is produced by administration of potassium-free fluids. Excessive administration of intravenous glucose or sodium chloride is stated to bring about or accentuate potassium deficiency, and potassium loss is also increased in the presence of nitrogen loss.[1] Potassium deficit may also be associated with adrenocortical hyperfunction which may result from surgical trauma or may be simulated by administration of ACTH or cortisone.[4]

There is a close relationship between potassium deficiency and alkalosis. Randall and his associates[9] state that hypochloremic alkalosis is in large part a primary potassium deficiency state. Martin and his co-workers[8] refer to the importance of alkalosis as a cause of serum potassium deficits. The development of alkalosis in association with potassium deficiency is dependent upon actual loss of chloride ions with loss of large quantities of gastric juice and upon disturbed physiology of the cell. In the presence of a potassium deficit in the extracellular fluid there is an attempt to re-establish the normal equilibrium by a shift of potassium ions from intracellular to extracellular fluid. Sodium ions, usually in excess due to loss of chloride and to the ability of the body to conserve sodium, enter the cells to restore their osmotic pressure and to replace the potassium. Some of the excess sodium ions also unite with bicarbonate to give rise to alkalosis. According to Elman,[5] when the sodium ions enter the cell the chloride ion cannot enter and is excreted, along with the potassium, thus leading to hypochloremia and alkalosis.

Symptoms. The symptom complex of this syndrome is manifested

clinically by apathy, lethargy, nervousness and irritability, muscular weakness, anorexia, ileus and abdominal distention, confusion and disorientation, delirium, aphonia, and in some instances by muscular twitchings and tetany. There may be peripheral edema, oliguria, and hemoconcentration. In occasional cases signs and symptoms of myocardial failure are pronounced. The symptoms of this syndrome are as a rule somewhat insidious in onset and appear about the fourth to the ninth postoperative day. If the condition is not recognized and treated adequately death may result from respiratory paralysis, myocardial lesions, ileus and malnutrition or a combination of these and other factors.

Potassium deficiency is associated with fairly specific electrocardiographic changes consisting of depressed, broadened T waves, prolonged Q-T interval, and depression of the S-T segment. Blood chemical findings of this syndrome include hypopotassemia, metabolic alkalosis, hypochloremia, and perhaps hypoproteinemia and other deficiencies.

Diagnosis. The diagnosis of the syndrome of potassium deficiency and hypochloremic alkalosis is dependent upon:

(1) A knowledge of the conditions likely to give rise to the syndrome.

(2) The presence of marked muscular weakness.

(3) Electrocardiographic changes indicative of potassium deficiency.

(4) Blood chemical findings of low serum potassium, hypochloremia and alkalosis.

(5) Prompt reversal of the clinical and laboratory abnormalities upon administration of an adequate amount of potassium.

Treatment. Therapy should be instituted immediately upon recognition of this syndrome. A refractory alkalosis of the type under discussion will, as a rule, respond to potassium therapy. The condition is made worse by administration of sodium chloride. The occasional case of extreme alkalosis in which large quantities of chloride ions seem indicated may respond to intravenous ammonium chloride therapy. The drug of choice for potassium therapy is potassium chloride. Oral therapy is to be preferred but is seldom feasible since potassium deficiency is usually observed in patients who are unable to take food or medication by mouth, or who have a continuous gastric suction or are vomiting consistently. In the occasional case where oral therapy is possible, 2 Gm. of potassium chloride may be given in fruit juice every four hours or a similar

dosage may be provided in tablet form, the drug being available in 5 gr. enteric coated tablets. It should be remembered that a dramatic improvement usually accompanies the oral intake of food in the patient with a potassium deficit, and foods rich in potassium should be given. Chief among these foods are beef broth and fruit juices.

If oral therapy is not feasible, potassium chloride may be given intravenously or subcutaneously. The sterile salt may be added to any intravenous solution. Ten cc. ampules containing 20 mEq. per liter or 1.49 Gm. of potassium chloride are convenient and safe for addition to standard intravenous solutions. A prepared solution containing 3 Gm. of potassium chloride in 1,000 cc. of invert sugar solution is also now available and affords a convenient means of intravenous potassium therapy. Darrow's solution containing 6 Gm. of sodium chloride and 2.7 Gm. of potassium chloride per liter may be given by hypodermoclysis.

Caution should be exercised in the intravenous administration of potassium chloride. A fatal outcome due to cardiac arrest may follow too rapid administration or the use of a too highly concentrated solution. Howard and Carey[7] recommend that solutions containing 40 to 90 mEq. of potassium per liter be given at an average rate of 120 drops per minute and not to exceed 180 drops per minute. The total dosage of potassium for a 24 hour period will vary with the degree of the deficit and the daily loss. Eliel, Pearson, and Rawson[4] have given up to 160 mEq. per liter (11.9 Gm.) in one day without ill effect. Careful observation is essential during the course of intravenous potassium therapy. Frequent clinical examinations and laboratory studies, including determinations of urinary output, serum chloride CO_2 combining power, serum potassium and sodium should be done. Serial electrocardiographic studies are useful, since characteristic changes are noted in hyperpotassemia, as well as hypopotassemia. Renal disease with diminished output and a serum potassium of 5.3 mEq. per liter contraindicate the intravenous use of potassium.

The prophylactic use of potassium should be considered along with therapy of the actual deficiency state. Sufficient emphasis has not been placed on this phase of potassium therapy. The syndrome of potassium deficit and alkalosis herein described may be prevented in patients being maintained on intravenous fluids by parenteral administration of potassium. The usually accepted dosage varies from 3 to 6 Gm. per 24 hours.

A case previously reported by Gillespie and Sanders[6] affords a typical example of the syndrome of potassium deficiency and hypo-

chloremic alkalosis herein described and demonstrates a good response to therapy in a patient whose condition was critical before recognition of the deficiency state. A resume of this case follows.

Case Report

A 56 year old white man had a two thirds gastric resection, (Polya-Moynihan anticolic procedure) performed for an obstructing duodenal ulcer on July 11, 1950. The procedure was complicated by the presence of many dense adhesions, the result of a previous peritonitis and four previous intra-abdominal operations, and by a contracted deformed duodenum and a penetrating posterior wall ulcer adherent to the head of the pancreas. This increased the technical difficulty and the operative trauma in the region of the gastroenteric anastomosis.

The gastroenteric stoma failed to function for a period of 36 days after the gastric resection. Continuous gastric suction was maintained practically throughout this entire period, since any attempt to discontinue it was attended by vomiting of large quantities of bile stained fluid and obvious stomal obstruction. A roentgenogram on the ninth postoperative day showed distention of the afferent jejunal loop and obstruction of the efferent loop. On the eleventh postgastrectomy day the abdomen was reopened and an enteroenterostomy performed between proximal and distal limbs of the jejunal loop. The findings at this time were thickening and edema of the intestine and anastomotic area with a considerable number of newly formed adhesions but no organic obstruction. These were interpreted as being indicative of a deficiency state.

There was no appreciable improvement after the above procedure. There was continued loss of large quantities of bile and gastric juice. Feeding was entirely parenteral. The patient complained of general discomfort, hiccough, and extreme weakness. He became progressively worse; was unable to swallow; developed aphonia, mental confusion and finally coma. On the seventeenth postgastrectomy day he appeared to be moribund. Blood chemistry studies on this date revealed potassium 2.4 mEq. per liter, chlorides 64.5 mEq. per liter, and sodium 133.7 mEq. per liter. The CO_2 combining power of the blood was 93 volume per cent on the following morning.

Intravenous administration of potassium chloride was instituted upon recognition of the deficency state, and a 2 per cent solution of ammonium chloride was given intravenously to combat the alkalosis. The calculated dosage of ammonium chloride, according to Bodansky's[2] formula, was 2,000 cc. of the 2 per cent solution to lower the CO_2 combining power from 93 volume per cent to 50 volume per cent; however, when the patient had received 1,500 cc. a state of marked acidosis was observed. The respiratory rate increased to 72 per minute, and a CO_2 combining power determination was 24 volume per cent. This over correction was temporary, and by the next morning the CO_2 combining power was 85 volume per cent.

From the seventeenth to the thirty-second postgastrectomy day the patient received a total of 49.17 Gms. of potassium chloride intravenously. The largest daily dose given was 7.45 Gm. The CO_2 combining power decreased as the potassium deficiency was corrected, and the chlorides increased. The patient's general condition was much improved within a week after the start of intravenous potassium therapy; he was mentally alert and able to understand conversation although disturbed by continued inability to swallow and aphonia.

A jejunostomy was performed for feeding purposes on the twenty-fourth day following the gastric resection because of the persistent stomal malfunction. Profuse gastric hemorrhage occurring the day after this procedure was controlled in 36 hours by transfusions, vitamin K therapy and topical thrombin per Levine tube. Jejunostomy feeding with a homogenized milk formula, as advocated by Case and his associates[3]; administration of potassium chloride solution per jejunostomy; and return of the greater part of the bile and gastric juice obtained by gastric aspiration to the intestine through this route, resulted in rapid and progressive improvement.

The stomach was emptying on the thirty-seventh postgastrectomy day as indicated by marked diminution of gastric drainage and a roentgenogram showing barium passing through the gastroenteric stoma as well as the entero-enterostomy. The gastric suction was discontinued at this point and a progressive diet instituted. The improvement following oral intake of food was even more dramatic than after the jejunostomy, and the patient was able to leave the hospital in good condition on the twenty-fourth day after this procedure. He received a total of 27 Gm. of potassium chloride in a 12 day period per the jejunostomy tube. The last serum potassium determination, on the thirty-fifth postgastrectomy day, was 4.7 mEq.

This patient has subsequently had a cholecystectomy for chronic cholecystitis with cholelithiasis (Jan. 5, 1952) and a very interesting postoperative response was observed. On the third postoperative day he became very restless and began to vomit large amounts of bile. These symptoms subsided immediately after intravenous administration of 1,000 cc. of a .3 per cent solution of potassium chloride in 10 per cent invert sugar. This was repeated on the following day, and the patient retained food and made a rapid recovery. He was discharged from the hospital on the twelfth postoperative day. Eight days after discharge from the hospital he was in for a postoperative checkup, at which time he complained of a sense of fullness and gas on his stomach. He was started on potassium chloride tablets by mouth, taking one 5 gr. enteric coated tablet three times daily, and he insists that he feels much better while taking these tablets.

Discussion

Mild degrees of potassium deficiency with associated hypochloremia and alkalosis are probably of frequent occurrence, and prophylactic administration of potassium will not doubt correct and prevent the development of severe deficiency states. The accepted prophylactic dosage of potassium chloride is from 3 to 6 gms. daily. Favorable response to potassium therapy, similar to that observed following cholecystectomy in the case herein reported, has been noted by the author in a number of cases. A patient having had surgery on the gastrointestinal tract, or who has some intra-abdominal disease, such as a perforated appendix, will often become drowsy and lethargic and develop varying degrees of ileus. Dramatic response may follow intravenous administration of potassium chloride to these patients, although serum potassium determinations may be normal.

The possibility of a chronic potassium deficiency state is suggested by the apparent benefit derived from orally administered potassium chloride after cholecystectomy in the above described case. This is merely a clinical impression and has not been verified by laboratory studies.

REFERENCES

1. Bellet, S., et al: Effect of vomiting due to intestinal obstruction on the serum potassium, Am. J. Med. *6:*712 (June) 1949.
2. Bodansky, O.: Symposium on medical therapeutics; parenteral fluid therapy, M. Clin, North America *34:*395 (March) 1950.
3. Case, C. T., et al: Observations in jejunal alimentation, Surgery *26:*364 (Sept.) 1949.
4. Eliel, L. P.; Pearson, O. H., and Rawson, R. W.: Postoperative potassium deficit and metabolic alkalosis, New England J. Med. *243:*471 (Sept. 28) 1950, 518 (Oct. 5) 1950.
5. Elman, R.: Surgical Care, New York, Appleton Century Crofts, 96, 1951.
6. Gillespie, C. E., and Sanders, R. L.: Subtotal gastrectomy complicated by mineral deficiency, especially potassium, A. M. A. Arch. Surg. *63:*9 (July) 1951.
7. Howard, J. E., and Carey, R. A.: Use of potassium in therapy, J. Clin. Endocrinol. *9:*691 (Aug.) 1949.
8. Martin, H. E., et al: Etiology and treatment of serum potassium deficits, J. A. M. A. *147:*24 (Sept. 1) 1951.
9. Randall, H. T., et al: Potassium deficiency in surgical patients, Surgery *26:*341 (Sept.) 1949.
10. Trail, R., and Elkinton, J. R.: Potassium deficiency and the role of the kidney in its production, J. Clin. Invest. *28:*99 (Jan.) 1949.

RUPTURED ABDOMINAL AORTIC ANEURYSM

With Retroperitoneal Hemorrhage Simulating Acute Appendicitis*

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A RETROPERITONEAL hemorrhage secondary to a rupture of an abdominal aneurysm may produce signs and symptoms simulating acute appendicitis with localized peritonitis.

Mr. J. W., a white man age 70, was admitted to Glockner-Penrose Hospital with a diagnosis of acute appendicitis. Upon entrance to the hospital an exploratory roentgenologic examination of the abdomen was done for renal calculus because of a previous history of renal colic and urinary infection. No evidence of renal stones was found. Upon further questioning, the patient admitted to having had an occasional blood pressure of 200/100. On the day of his illness the blood pressure was 140/80.

The patient was examined by me two hours after entrance to the hospital and presented the following history. The day before being seen by the internist he suffered an "uneasiness" in his abdomen which he attributed to indigestion. He took a laxative and had three formed bowel movements within a twenty-four hour period. He developed more vague generalized distress in the upper abdominal quadrants. That night there was more severe pain that localized in the right lower quadrant by the next morning. There was syncope, nausea, and loss of appetite but no vomiting. He noticed that his abdomen was distended.

Upon examination the pulse rate was 76 beats per minute, regular, and strong in quality. The color of the skin was pale but his wife stated that this was his usual color. There was no evidence of jaundice. The abdomen was rigid in its right half with marked tenderness localized over the cecum and severe rebound tenderness referred to the appendiceal region. The peristaltic sounds were normal. Percussion of the abdomen caused severe subjective pain referable to the right lower quadrant. The aorta was enlarged but this fact was difficult to evaluate due to the rigidity of the abdominal wall. A rectal examination localized the tenderness to the appendix. The psoas sign was positive.

The leukocyte count was 16,800 per cu. mm. The differential blood count contained 92 per cent mature polymorphonuclear cells. The urinalysis revealed albumin, an occasional red and white blood cell and several granular casts. The temperature was 99.6 F.

The signs and symptoms in this patient were that of acute appendicitis. With this diagnosis made, the patient was operated upon about 26 hours after the onset of the disease. Upon reaching the peritoneum through a transverse muscle splitting incision, blood was encountered in the retroperitoneal tissues. It was apparent that the disease was not appendicitis but a retroperitoneal hemorrhage from a probably ruptured aortic aneurysm. The peritoneal cavity was then opened and the appendix found to be normal. The peritoneal cavity contained some serosanguinous fluid and further evidence of considerable

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retroperitoneal hemorrhage in the right lower quadrant. The abdominal aorta was explored and found to contain a large aneurysm which had ruptured into the right lower quadrant. The abdomen was closed. The patient continued to fail rapidly and expired in shock about eight hours after surgical exploration. During the postoperative hours the abdomen was distended and a paralytic ileus was evidenced. The only treatment instituted was continuous oxygen, intravenous fluids, and sedation.

Fig. 1. Postmortem roentgenogram of aortic aneurysm of case presented illustrating calcification in wall of aneurysm similar to that seen in flat roentgenogram of abdomen preoperatively.

At postmortem examination the operative findings were corroborated (fig. 1). The rent in the inferior, lateral aspect of the aortic aneurysm was found to be the point from which the hemorrhage had occurred. The only additional findings were the marked generalized arteriosclerotic vessels and numerous bilateral large cysts of the kidneys, interspersed between relatively normal kidney parenchyma. The final diagnosis was an abdominal aortic aneurysm with a large thrombus formation, rupture of the aneurysm into the right lower quadrant with retroperitoneal hemorrhage. The aneurysm was secondary to the arteriosclerosis. Death was due to shock, secondary to the ruptured abdominal aortic aneurysm and associated hemorrhage.

Discussion

Retroperitoneal hemorrhage due to any etiologic factor (fig. 2) produces irritation of the peritoneum and may present signs and symptoms of a generalized or localized peritonitis. When the hemorrhage is secondary to an arteriosclerotic aneurysm the patient is usually over 50 years of age and has evidence of arteriosclerosis. The clinical signs and symptoms in the patient

presented simulated acute appendicitis and the diagnosis could not be established without a celiotomy. The onset of an attack of retroperitoneal hemorrhage frequently occurs as a sudden abdominal pain with no previous history of similar attacks. The abdominal pain may be generalized or localized to

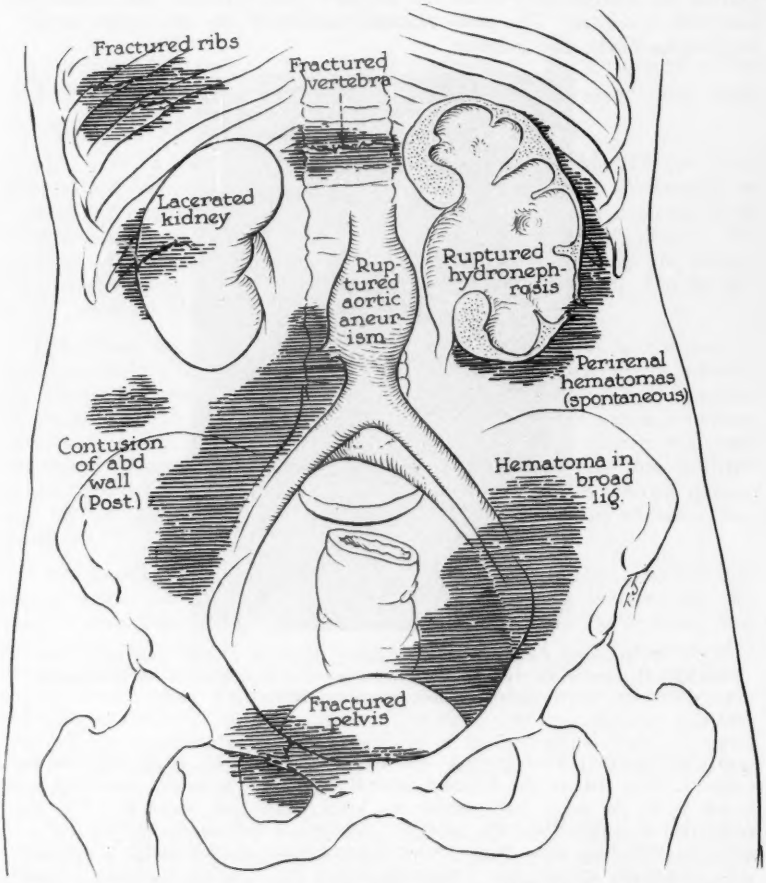

Fig. 2. Diagrammatic illustration of the common etiologic factors in retroperitoneal hemorrhage.

either side of the lower abdomen and often it is referred into the legs. Neck pain can be a common complaint. At intervals of minutes to several hours the patient may complain of feeling faint and may collapse. Following collapse there is usually a marked pallor associated with a drop in the blood pressure and an increase in the pulse rate. An abdominal mass may be palpable. The abdomen is usually rigid and tender at the onset but as the disease progresses the rigidity diminishes and a paralytic ileus developes. This ileus[1] may appear from 24 hours to 5 days after the onset of the retroperitoneal hemorrhage.

The distension associated with ileus is often marked and does not respond to the usual methods of treatment. A bruit may be heard over an aneurysm but not always heard over a hematoma resulting from a rupture of an aneurysm. Severe vomiting and hiccoughing is often present. The laboratory findings are of no diagnostic value early in the disease but later an anemia may develop. Serologic tests are usually negative.

Fig. 3. Illustrates the loss of the psoas shadow on the right side of the abdomen which was due to a retroperitoneal hemorrhage in case presented. Note calcification paravertebrally on the right side which is suggestive of calcification of the abdominal aneurysm.

Fig. 4. Roentgenogram of the abdomen illustrating an abdominal aortic aneurysm. Arrows point to the wall of the aneurysm which shows up largely because of the calcification.

The most valuable procedure in the diagnosis of an abdominal aortic aneurysm is the roentgenologic examination of the abdomen. This is illustrated in the case report presented. The loss of the psoas shadow on the right side of the abdomen which the patient illustrated, was due to a retroperitoneal hemorrhage (fig. 3). This sign should have been recognized as a clue to the diagnosis. In addition to this finding there was evidence of calcification in the aneurysm which is also suggestive of aneurysm. These calcium deposits are seen in the roentgenologic films of the aortic aneurysm at postmortem, which can be superimposed over the calcium deposits in the film taken preoperatively (figs. 1 and 3). One must consider a diagnosis of retroperitoneal hemorrhage from a ruptured arteriosclerotic aortic aneurysm when a roentgenologic examination of the abdomen reveals retroperitoneal soft tissue pathology such as the loss of the psoas shadow which is associated with clinical signs of peritonism and a calcified abnormal mass in the midabdomen.

If one is suspicious of an abdominal aneurysm a lateral examination of the spine should be done in additions to the usual anteroposterior roentgenologic examination. If a pressure erosion of the bodies of the vertebrae without destruction of the intervertebral cartilages is found, it is pathognomonic of an abdominal aneurysm. Kampmeier[2] found that the roentgenologic examination for abdominal aneurysm was positive in 75 per cent of the cases and that 50 per cent of the cases showed the pathognomonic erosion of the bodies of

vertebrae. Thus in addition to visualizing the calcified aortic aneurysm (fig. 4) and the erosion of the bodies of the vertebrae with intact intervertebral cartilages, an obliteration of the normal psoas muscle shadow must be added to the signs of retroperitoneal pathology which retroperitoneal hemorrhage may be an etiologic factor. However, if the diagnosis is not apparent after complete investigation, it may be necessary to open the abdomen to establish the diagnosis. The prognosis in ruptured abdominal aortic aneurysm is very poor. Death from retroperitoneal hemorrhage due to rupture of an aneurysm usually occurs within six months after the discovery of the condition.

Conclusions

A case report of retroperitoneal hemorrhage secondary to a rupture of an abdominal aortic aneurysm with signs and symptoms simulating acute appendicitis is presented.

A roentgenologic examination of the abdomen is most valuable in the diagnosis of abdominal aneurysm and its sequelae. The loss of the psoas muscle shadow indicates retroperitoneal pathology and may be due to retroperitoneal hemorrhage. The erosion of the lumbar vertebral bodies without destruction of the intervertebral cartilages is pathognomonic of abdominal aortic aneurysm. The calcification in the aneurysm is frequently observed on roentgenologic examination.

A celiotomy may be necessary to establish the diagnosis.

The prognosis in patients with retroperitoneal hemorrhage secondary to rupture of an aortic aneurysm is poor.

REFERENCES

1. Lenormant, C., and Cordier, G.: Du ballonnement abdominal dans les hemorrhagies sous-peritoneales, Presse med., *42*:1257 (Aug. 8) 1934.
2. Kampmeier, R. H.: Aneurysm of abdominal aorta: a study of 73 cases, Am. J. M. Sc. *192*:97 (April) 1936.

DUODENAL DIVERTICULA: CASE STUDIES

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DUODENAL diverticula are sac-like projections usually arising from the concave border of the duodenum. They are most commonly single, but many cases of multiple diverticula have been reported by several authors.[2,5] They vary in size from a centimeter or 2 to 5 or 6 centimeters in diameter. Only the larger ones seem to produce symptoms.

A diverticulum may take origin from any part of the duodenum. These seen in the first part have practically always resulted from a healed duodenal ulcer. During the phase in which there is activity at the ulcer site there is destruction of the mucosa and the muscular layers with the formation of an area of weakness. The second portion of the duodenum is the most common site and the diverticulum is found adjacent to that portion where the bile and pancreatic ducts perforate the duodenal wall. Those found in the third portion are similar to the diverticula seen in the remaining portion of the small intestine. Here they represent herniation of the mucosa and submucosa through the muscularis.

Finney[3] believes that congenital weak spots of the duodenum may exist. However, these areas cannot be demonstrated before the formation of the diverticulum. It is true that during development the duodenum undergoes more profound changes than any other part of the intestine due to the origin of the ducts of the pancreas and liver. With an increase in the intraluminal pressure within the duodenum a pulsion type diverticulum may result.

In a period of slightly over three and a half years, 1,588 upper gastrointestinal tract barium studies have been done and 5 cases having severe symptoms have been found. This is a percentage rate of .3 per cent. The symptoms were severe enough in each case for these patients to desire surgical relief. None of these patients had been benefited by a medical program which had been repeatedly tried. The asymptomatic duodenal diverticula found on routine upper gastrointestinal roentgenologic examination have not been considered in this study.

The symptoms when present are, pain of a gnawing character which may not be relieved by food, and weight loss occurring over a period of several months or even years. Nausea and vomiting may be present when there is inflammation with obstruction.

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Diarrhea is an infrequent symptom but may be present with an associated pancreatitis. Hemorrhage may occur with the presence of ulceration within the diverticulum and jaundice is an infrequent complication from an extrinsic pressure on the biliary system.

Fig. 1. Case 1. Diverticulum of second portion of duodenum.

Fig. 2. Case 2. Rarefaction of first portion of duodenum.

Fig. 3. Case 3. Diverticulum of second portion of duodenum.

Fig. 4. Case 4. Diverticulum of second portion of duodenum.

Physical examination reveals no striking or characteristic abdominal findings; however, tenderness in the right upper quadrant of the abdomen or epigastrium is frequently present.

Roentgenologic studies are the only positive method of establishing a diagnosis. This evaluation must include a careful fluoroscopic examination with manual palpation as well as the usual anteroposterior, laterals and various oblique and spot roentgenograms. In the erect position the diverticulum may show a fluid level capped with gas. Ordinarily the diverticulum empties its barium about the same time as the rest of the duodenum but it may retain it longer if there is a narrow neck present or if edema and inflammatory changes have occurred. A duodenogram may be of value. Knowing the exact location of the diverticulum is of importance when surgery is contemplated and a differential diagnosis can be established by careful roentgenologic studies.

The laboratory offers very little assistance from a diagnostic point of view. In all of our cases except 2, there was a rather marked fasting hypoacidity present. There was persistent occult blood present in the stool of 1 patient; however, no ulceration was found in the surgical specimen following its removal.

Fig. 5. Case 5. Diverticulum of second portion of duodenum.

Treatment becomes surgical only after a fair medical regime has failed to relieve symptoms. Repeated medical trials and the use of the anticholinergic agents may be in order. The surgical procedure of choice is excision of the diverticulum with inversion of the mucosa and approximation of the muscular layers. Inversion of the diverticulum into the duodenal lumen may be resorted to for those cases where excision is impractical. We think that constant suction on the stomach with an indwelling gastric tube is imperative for the first four postoperative days.

Mahorner[5] has reported a method for localizing a diverticulum which consists of inflating the duodenum with air at the time of operation. He also advises intubation of the common duct. This serves as a safeguard during the dissection and prevents a closure that may constrict the duct system. Opening the duodenum longitudinally for exploration with the index finger may aid in localizing the sac and will facilitate dissection, especially when the diverticulum is buried into or behind the pancreas. This incision is later closed in a transverse fashion.

Case Reports

Case 1. A 61 year old white farmer entered the hospital complaining of stomach trouble, constipation and cramps in the right upper quadrant. For the past 30 years he had been suffering from constipation and stomach trouble which manifested itself with a gnawing-type pain in the epigastrium, coming on in attacks and not associated with food. Recently there has been a loss of appetite, weakness and dark colored stools. He is required to take a laxative daily and has been taking insulin regularly since 1938. The patient has had an arrested tuberculosis since 1925. An appendectomy was done in 1922.

Examination of the chest revealed a mild deformity of the left clavicle secondary to an old injury. The lungs were normal to percussion and auscultation. Cardiovascular, heart rate 88 beats per minute, blood pressure 160/100. There was a fairly frequent extrasystole present and a systolic murmur at the apex.

Abdominal examination revealed tenderness over the entire right costal border and epigastrium. Urinalysis was normal; erythrocytes 2,130,000 per cu. mm.; leukocytes 7,300 per cu. mm.; neutrophils 78 per cent; lymphocytes 22 per cent; hemoglobin 4.6 Gm. per 100 cc.; hematocrit 37 per cent. Stools, positive for occult blood; blood sugar 138 mg. per 100 cc.; sputum, negative for acid fast bacilli; gastric analysis fasting specimen, total acidity 105 units, free hydrochloric acid (HCL) 115 units. Roentgenogram, heart and lung fields were within normal limits. Cholecystogram, normal functioning gallbladder. Gastrointestinal series, there is a diverticulum of the second portion of the duodenum.

After preparation the patient was taken to the operating room where under general anesthesia the peritoneal cavity was entered through a right rectus incision. The duodenum was exposed and a large diverticulum was excised. The mucosa was inverted and the muscularis and serosa approximated over the mucosa. The abdominal wound was closed in anatomical layers and an indwelling nasal tube was passed into the stomach. The postoperative course was uneventful except for a stitch abscess in the incision.

The patient has gained weight, is tolerating his diabetic diet and is doing light work on his farm. Abdominal pain has not been present for two years.

Case 2. A 35 year old white male student entered the hospital complaining of pain in the upper right quadrant of his abdomen and of rectal bleeding. In 1945 while in Europe, the patient developed an acute diarrhea for which hospitalization was required and he was treated for one month with a sulfonamide. Since 1945 he has had bouts of severe upper right quadrant pain about every

six months. With this pain the patient has an associated diarrhea and passes small quantities of blood from the rectum. Cystoscopic examination and retrograde pyelograms were normal on a previous examination.

Physical examination, lungs normal to percussion and auscultation; cardiovascular, heart rate 72 beats per minute, blood pressure 124/86. The heart was not enlarged and there were no murmurs present. Abdomen, tenderness in right upper quadrant which radiates to cardiac and right scapular area. Rectal examination was normal, sigmoidoscopic was negative.

Routine blood work and urinalysis were within normal limits. Glucose 128 mg. per 100 cc.; urea nitrogen 14 mg. per 100 cc.; creatinine 0.80 mg. per 100 cc.; gastric analysis fasting specimen, total acidity 18 degrees, free HCL 0 degrees; ½ cc. histamine, total acidity 11 degrees, free HCL 0 degrees; serum amylase 37 mg. per 100 cc. Roentgenogram, heart and lung shadows were within normal limits and cholecystogram revealed a normal functioning gallbladder. Gastrointestinal series, a rarefied area was present in the duodenal cap.

After preparation the patient was taken to the operating room where under general anesthesia the abdomen was opened and explored. An aberrant pancreatic tissue tumor was present just proximal to the pylorus in the posterior wall of the stomach. A partial gastric resection was done which included the small diverticulum in the first part of the duodenum. A Levin tube was passed into the stomach and the wound was closed in layers.

On the fourth postoperative day he developed a left basal pneumonia which responded to antibiotic therapy. The patient has gained weight; has been free of symptoms for over two years; pain is completely gone and he has resumed his course of study.

CASE 3. A white gang foreman, 55 years of age, entered the hospital complaining of stomach trouble. For several years he has had attacks of pain in the upper abdomen. This pain has not been accompanied by nausea, vomiting or the passage of black stools. He has lost 18 pounds of weight in the past 30 days, has had chronic constipation and is required to take laxatives daily.

Physical examination, lungs were normal to percussion and auscultation. Cardiovascular, no cardiac enlargement or murmurs detected; pulse 80 beats per minute, blood pressure 120/80. Abdomen, tenderness in the right upper quadrant.

Urinalysis and routine blood work were normal. Urea nitrogen 11.9 mg. per 100 cc.; chlorides (serum) 485 mg. per 100 cc.; creatinine 0.80 mg. per 100 cc.; serology was negative; stools negative for blood and parasites; gastric analysis, total acidity 16 degrees, free HCL 0 degrees, histamine injection total acidity 83 degrees, free HCL 60 degrees. Roentgenogram, heart and lungs were within normal limits. A diverticulum of the second portion of the duodenum was demonstrated.

The patient was prepared and taken to the operating room where under general anesthesia the peritoneal cavity was opened. The duodenum was mobilized and opened longitudinally and the diverticulum was located by digital exploration. The diverticulum was excised, the mucosa inverted and muscularis approximated over the mucosa. A Levin tube was passed distal to the suture line. The duodenum was then closed transversely and sutured into position and the wound closed in anatomical layers.

The postoperative course was uneventful, the Levin tube was removed on the fourth day and an ulcer dietary regime instituted. At the time of discharge the patient was tolerating a regular diet well and he has been asymptomatic for the past six months.

CASE 4. A 35 year old white male student entered the hospital complaining of pain in the epigastrium. He had had episodes of pain in the epigastrium for some nine years. This pain radiated to the back and with it was an associated weakness, headache and nervousness.

Physical examination, lungs were clear to auscultation and percussion. The heart was not clinically enlarged and there were no murmurs; pulse rate 80 beats per minute, blood pressure 130/88. The abdomen was soft and there were no masses or tenderness present.

Routine blood work was normal, urinalysis negative, stools negative for blood and parasites; gastric analysis fasting specimen, total acidity 8 degrees, free HCL 0 degrees, histamine ½ cc. total acidity 76 degrees, free HCL 17 degrees, serum amylase 76 mg. per 100 cc., serum bilirubin 1 mg. per 100 cc. Roentgenogram, heart and lung shadows were within normal limits. Gallbladder series after priodex, gallbladder fills and empties well, no evidence of stones. Gastrointestinal series in prone position, a large diverticulum of the second portion of the duodenum is present.

The patient was prepared and taken to the operating room where under general anesthesia a high right rectus muscle splitting incision was made and the peritoneum opened. The duodenum was mobilized and reflected medially, opened longitudinally and explored digitally. A large diverticulum which extended medially below the head of the pancreas was detected. The diverticulum was then dissected and inverted into the duodenum, the mucosa approximated with interrupted sutures and the muscularis closed over the mucosa. The longitudinal incision in the duodenum was closed transversely and the duodenal serosa was resutured. The wound was closed in anatomical layers.

For four postoperative days constant suction was applied with an indwelling gastric tube. Following this an ulcer dietary regime was instituted. Six months following surgery the patient had gained 10 pounds and was asymptomatic. He is now tolerating a regular diet, is attending a trade school and is asymptomatic over a period of one and a half years.

CASE 5: A 62 year old farmer entered the hospital complaining of epigastric pain of a cramping character. Four months ago the patient developed pain in the epigastrium and had frequently become nauseated and vomited. There had been no weight loss nor jaundice.

Physical examination, the lungs were normal to percussion and auscultation. The heart was not clinically enlarged and there were no murmurs; pulse rate 80 beats per minute, blood pressure 180/90. Examination of the abdomen showed tenderness in the epigastrium.

Routine blood work and urinalysis were normal; urea nitrogen 18.0 mg. per 100 cc.; creatinine 1.05 mg. per 100 cc.; sedimentation rate 20 mm. per hour; blood chloride 379 mg. per 100 cc.; glucose 103 mg. per 100 cc.; serum amylase 84 mg. per 100 cc. Roentgenogram, heart and lungs were within normal limits. A small diverticulum was present in the second portion of the duodenum. The duodenal curve may be slightly enlarged.

After preparation the patient was taken to the operating room where under

general anesthesia the abdomen was opened through a transverse incision. Exploration revealed a mass the size of a tennis ball arising from the second portion of the duodenum and extending posteriorly into the pancreas. There was considerable inflammatory reaction present, the periportal lymph nodes were enlarged and soft and the omentum was anchored to the mass. Biopsy specimen was taken for frozen section and no tumor cells were seen. Due to the inflammatory reaction a retrocolic gastroenterostomy was done. The wound was closed in anatomical layers and the patient returned to the ward in good condition.

The postoperative course was complicated by a rather severe potassium deficiency which responded readily to therapy. The patient was discharged completely free of symptoms; is now working on his farm and has been tolerating his regular diet well for 12 months.

Five cases have been reported. All patients were men, the average age being 49 years. Duration of symptoms varied from 4 months to 30 years. Pain in the right upper quadrant of the abdomen or the epigastrium was the only significant symptom. Physical examination was normal except for tenderness in the upper right quadrant of the abdomen in 4 patients. Treatment consisted of excision of the diverticula in 2 cases, inversion of the diverticulum in 1 case, a partial gastrectomy for a co-existing aberrant pancreatic rest in the wall of the antrum of the stomach, and a posterior gastroenterostomy for a severe inflammatory reaction around the diverticulum.

Conclusions

Five cases of duodenal diverticula, treated by surgery, have been presented; there has been no operative mortality. All patients are now symptom free, have gained weight and have returned to their original occupations. When medical treatment has failed and severe symptoms persist, surgical exploration is justified.

REFERENCES

1. Boland, F. K., Jr.: Acute perforated duodenal diverticulum, Surgery *6:*65 (July) 1935.
2. Edward, H. C.: Diverticula of the duodenum, Surg., Gynec. & Obst. *60:*946 (May) 1935.
3. Finney, J. M. T., Jr.: Duodenal diverticula, their significance and treatment, Sou. Surgeon *11:*543 (Aug.) 1942.
4. Lahey, F. H.: Surgery of duodenum, New England J. Med. *222:*444 (March 14) 1940.
5. Mahorner, H.: Diverticula of the duodenum; a report of 8 surgical cases, Surgery *133:*697 (May) 1951.
6. Mahorner, H., and Kisner, W.: Diverticula of the duodenum and jejunum, with report of new technical procedure to facilitate their removal and discussion of their surgical significance, Surg., Gynec. & Obst. *85:*607 (Nov.) 1947.

EFFECTS OF EARLY AMBULATION IN PRIMARY INGUINAL HERNIOPLASTY*

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EARLY ambulation in the management of the surgical patient during the postoperative period has received considerable attention during the past several years. Greater recognition of the beneficial effects of this method of therapy has resulted. This is due to the many favorable reports which have appeared in the literature.[3,5,7,10-13,15,17,20-22]

There has been and still is a reluctance on the part of many physicians and surgeons to permit early ambulation of surgical patients, mainly because of the misconception that such a policy has a deleterious effect upon wound healing and therefore imposes an increased chance for postoperative hernia and wound disruption. This concept is not substantiated by the facts presented in many reports. According to the wound healing curve by Speir, the interval between the third to the fourth day after surgery represents the weakest period in the tensile strength of the wound.[18] Wound healing is not complete until the twelfth or fourteenth day. According to D'Ingianni[9] ambulation on the eighth to the tenth day is undesirable, since it is at this time that the sutures are the weakest and the wound is not healed. Leithauser[14,15] noted that prolonged bed rest depresses circulation in the area of the wound to delay healing. Wound disruption has occurred more frequently in those patients who were ambulated late in the postoperative period.[1,2,4,6,8,9,14,16,20,23]

The recurrence rate for primary inguinal hernioplasty in the majority of series recently reported in which early ambulation was the policy has shown no increase, and in many, a definite decrease.[3,5,7,10-13,15,17,21,22]

This report is based upon a controlled study of 564 unselected male patients who were operated upon for the repair of a primary inguinal hernia at this hospital during a period of three years ending in 1949. Prior to 1946 this same type of surgical repair had been developed over a period of 10 years and was the hernioplasty of choice of one of the authors (L.T.P.) and two former associates in

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*Sponsored by the Veterans Administration with the approval of the Chief Medical Director. Statements and conclusions published by the authors are a result of their own study and do not necessarily reflect the opinions or policy of the Veterans Administration.

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several thousand cases. In the majority of these cases, the patients were ambulated on the fourteenth to the sixteenth day. The recurrence rate was under 4 per cent. The presentation of these facts is intended to establish the soundness of this type of hernia repair and to eliminate the introduction of any new factor from the standpoint of surgery which might in itself affect the recurrence rate and thereby void the results of any other changes in postoperative management.

In conducting this study, the hernioplasty technic was taught to 18 other surgeons and residents on our staff, so that basically the type of repair was the same in the entire series of patients presented in this report. The hernia repair consists of a combination of the original technics of Bassini, Halsted, and Andrews with several modifications and additions developed from our own experiences over a period of many years. This technic has been fully described and portrayed in another report.[19]

A non-absorbable suture material was employed in the entire series. In 37.3 per cent or 243 operations, cotton was used, and in 62.2 per cent or 399, silk was the suture of choice.

Six hundred and forty-two operations were performed; in 78 or 13.8 per cent of the patients the hernias were bilateral. Bilateral repairs were not accomplished on the same day; the opposite side was repaired 7 to 14 days later. Our studies and those of others in this field have shown that the recurrence rate is much higher when both sides are repaired at the same time. In 96 per cent the operation was performed under spinal anesthesia, and in the remaining 4 per cent under a general anesthetic.

The patients ranged from 18 to 76 years of age. There were 334 patients in the group under 50 years of age and 230 in the group over 50. Seven per cent were over 60 years old.

The inguinal hernias in this series were of all types; 60 per cent were indirect, 18 per cent direct, 21 per cent combined (direct and indirect), and 1 per cent sliding in type.

Results

The patients were divided into three groups according to the day of ambulation. There was no selectivity of any of the groups studied. Group 1 patients were ambulated on the fourteenth postoperative day; group 2, on the seventh day; and group 3, on the first day.

Group 1 (fourteenth day) consisted of 116 patients, representing 125 operations. Eighty-five per cent of these patients were followed

four years. There were two recurrences, a recurrence rate of 2 per cent.

Group 2 (seventh day) consisted of 247 patients, representing 281 hernioplasties. Eighty-four per cent of these patients were followed three years. There were two recurrences, an incidence of 0.95 per cent.

Group 3 (first day) consisted of 201 patients, representing 236 operations. Eighty-seven per cent of these patients were followed for two years. There were three recurrences, a rate of 1.71 per cent (table 1).

TABLE 1

Recurrence Rates Based on Day of Ambulation

Group	No. Patients Followed	No. Operations	% Recurrence Rates Based on	
			No. Patients	No. Operations
1. Ambulatory 14th day	98	105	2.0	1.90
2. Ambulatory 7th day	209	235	0.95	0.85
3. Ambulatory 1st day	175	202	1.71	1.48
Totals	482	542	1.45	1.27

There were 63 (9.8 per cent) postoperative complications in the 3 groups studied. The most frequent were pulmonary, either atelectasis or pneumonia. The complication rate was significantly reduced by early ambulation, occurring about three times more frequently in the patients who were ambulated on the fourteenth day, as compared to the group who were ambulated on the first day (table 2).

Wound complications occurred less frequently in the patients who were up early and catherization was required less frequently. Catherization was necessary in 8.3 per cent of the patients in the late group and in only 0.8 per cent of the early group.

Comment

A survey of the literature revealed that 85 to 90 per cent of recurrences following a primary inguinal hernioplasty occur during the first two years. In over 70 per cent of our series the patients were followed longer than a two year period.

The recurrence rate for the entire series based upon the number of patients followed was 1.45 per cent, and based upon the number of operations performed on the number of patients followed, it was

TABLE 2

Postoperative Complications According to Day of Ambulation

Type	Group 1 125 Operations 14th P.O. Day	Group 2 281 Operations 7th P.O. Day	Group 3 236 Operations 1st P.O. Day	Totals & Per Cent 642 Operations
Pulmonary				
Atelectasis and/or pneumonia	8	4	3	15 (2.3%)
Upper respiratory infection	3	3	3	9 (1.4%)
Embolism	0	1	0	1 (0.1%)
Wound				
Hematoma	1	5	2	8 (1.2%)
Infection	4	6	2	12 (1.9%)
Ileus	3	4	0	7 (1.0%)
Thrombophlebitis	2	0	1	3 (0.04%)
Miscellaneous	1	3	4	8 (1.2%)
Totals and per cent	22 (17.6%)	26 (9.2%)	15 (6.3%)	63 (9.8%)

1.27 per cent. There were seven recurrences in this series. Early ambulation did not increase the recurrence rate; in fact, the recurrence rate was less for patients who were ambulatory on the first day as compared to those who were ambulatory on the fourteenth day.

Early ambulation was of tremendous value in reducing the postoperative complications. Complications occurred three times as frequently in the patients who were in the late ambulatory group. The most effective reduction occurred in the incidence of pulmonary complications.

Wound complications were not increased as a result of early ambulation; in fact, the incidence was 4 per cent in the late group as compared to 1.6 per cent in the early group.

The early ambulatory group represented a saving of about 1600 hospital days when compared to the late ambulatory groups. In these days of high hospital costs and shortages of hospital beds this is of great economic significance.

Summary

A report of the effects of early ambulation upon the recurrence and complication rates in patients operated upon for the primary repair of inguinal hernia is presented. This study includes 564 unselected male patients upon whom 642 inguinal hernioplasties were performed during a period of three years, ending in 1949. A follow-up was obtained in over 85 per cent of the patients covering a period of one to four years.

The operation performed was accomplished by 18 surgeons and residents using an identical technic. This technic was a combined procedure of Bassini, Halsted, and Andrews. Cotton or silk was the suture material employed.

The patients were ambulated on the first, seventh, or fourteenth postoperative days, representing 201, 247, and 116 patients respectively. The recurrence rate was slightly higher for the late ambulatory group as compared to the intermediate and early groups. In the combined late ambulatory group the incidence of recurrence was 1.37 per cent as compared to 1.48 per cent for the patients who were ambulatory on the first day. The recurrence rate for the entire series based upon the number of operations performed was 1.27 per cent.

The postoperative complication rate was significantly lower in the early ambulatory group, being 6.3 per cent as compared to 9.2 and 17.6 per cent in the other groups.

It appears from these studies that early ambulation did not increase the recurrence rate in primary inguinal hernioplasty. A marked reduction in the complication rate was effected by this program; the period of hospitalization was reduced, and the patient was more quickly rehabilitated.

REFERENCES

1. Byron, R. L., Jr., and Bell, H. G.: Early ambulation, West. J. Surg. *57:*284 (July) 1949.
2. Blodgett, J. B., and Beattie, E. J.: Early postoperative rising; statistical study of hospital complications, Surg., Gynec. & Obst. *82:*485 (April) 1946.
3. Blodgett, J. B., and Beattie, E. J.: Effect of early postoperative rising on recurrence rate of hernia, Surg., Gynec. & Obst. *84:*716 (April) 1947.
4. Blodgett, J. B.: Early ambulation following surgical procedures, Bull. New York Acad. Med. *25:*176 (March) 1949.
5. Burch, J. C., and Fisher, H. C.: Early ambulation in abdominal surgery, Ann. Surg. *24:*791 (Oct.) 1946.
6. Burch, J. C., and Bradley, C. F.: Wound disruption and early ambulation, Ann. Surg. *125:*768 (June) 1947.
7. Conkling, R. W.: Surgical treatment of inguinal hernia (review of the literature), Surgical Staff Meeting Bull., Veterans Hospital, Des Moines, Ia., *3:*1 No. 11 (June) 1951.
8. Davison, T. C.; Letton, A. H., and Hendry, W. M.: Early ambulation; its advantages in 505 cases, J.M.A. Georgia *36:*299 (Aug.) 1947.
9. D'Ingianni, V.: Rapid postoperative mobilization, New Orleans M. & S. J. *100:*80 (Aug.) 1947.
10. Jackson, P. P.: Stainless steel and early ambulation in hernia repair, J. Internat. Coll. Surgeons *12:*497 (July-Aug.) 1949.
11. Katz, I. A.: Early ambulation in the management of surgical patient (review of the literature) Surgical Staff Meeting Bull., Veterans Hospital, Des Moines, Ia., *4:* No. 4 (Nov.) 1951.
12. Koontz, A. R.: Some common fallacies and confusions with regard to repair of inguinal hernia, J.A.M.A. *141:*336 (Oct. 8) 1949.
13. Lee, H. C.: Use of early rising and early ambulation following surgical operations, Virginia M. Monthly *75:*435 (Sept.) 1948.
14. Leithauser, D. J.: Early Ambulation and Related Procedures in Surgical Management, Springfield, Ill., Charles C. Thomas, Chap. 7, 1946.
15. Leithauser, D. J.: Early Ambulation and Related Procedures in Surgical Management, Springfield, Ill., Charles C. Thomas, Chap. 14, 1946.
16. Leithauser, D. J.: Rational principles of early ambulation, J. Internat. Coll. Surgeons *12:*368 (May-June) 1949.
17. Martin, D. J.: Active convalescence of hernial repairs, Brit. M. J. *2:*531 (Oct.) 1944.
18. Speir, E. B.: Symposium on use and abuse of bed-rest; surgery, West. J. Surg. *54:*328 (Aug.) 1946.
19. Palumbo, L. T.; Paul, R. E., and Emery, F. B.: Results of primary inguinal hernioplasty, Arch. Surg. *64:*384 (March) 1952.
20. Pinson, J. H., Jr., and Webb, G. M.: Early and late postoperative ambulation, J. Arkansas M. Soc. *44:*217 (March) 1948.
21. Powers, J. H.: Prompt postoperative activity after hernioplasty; its influence on incidence of complications and rate of recurrence, Arch. Surg. *59:*601 (Sept.) 1949.
22. Pratt, G. H.: Steel wire sutures, local anesthesia, and immediate ambulation in treatment of hernia, Surg., Gynec. & Obst. *86:*530 (May) 1948.
23. Spang, A. J., and Spang, J. S.: Early ambulation following surgery, Am. J. Surg. *71:*316 (March) 1946.

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THE SEQUELAE OF PHLEBITIS

Within the past two decades considerable attention has been directed toward the problem of acute phlebitis and pulmonary embolism. The morbid anatomy and altered physiology have been minutely studied. As a result, management of this condition has improved both from a prophylactic and a therapeutic standpoint.

There remains, however, the less frequently discussed problem of late sequelae of venous clotting. In many cases the lapse of time between the initial episode of phlebitis and the appearance of later symptoms is so great that the first bout may well have been forgotten.

The lower leg stasis syndrome is a common sight in surgical clinics and is well known to physicians from house officer to attending surgeon. It affects predominantly younger age groups than does arterial disease and may seriously limit employability of the wage earner.

The initial phlebitic process involves extensive clotting in the venous tree, causing obstruction and the production of peripheral edema, tenderness, and related changes in the skin. After collateral

circulation has developed with its compensatory changes, the extremity may improve or even return to an essentially normal appearance. Deep clots persist, however, and the process enters the second stage of development, in which thrombi in the venous trunks undergo recanalization and the continuity of long lengths of the venous pathways may be restored.

The formation of new channels through old clots is more harmful than helpful. Although recanalization relieves obstruction, the absence of functioning valves in the vein renders it useless. In a normal vein, the combination of functioning valves and the action of surrounding muscles constitutes a well-designed peripheral venous pump. In an erect position, the long hydrostatic column of blood from the right atrium to the foot is conveniently and purposefully broken up into short segments by valves, which, with the help of muscle contraction, continually direct blood toward the heart.

In a diseased vein with recanalization, the column of liquid is *unbroken* and muscle action is useless. Tissues in the lower leg and foot feel the full impact of this long column of blood as it transmits its hydraulic force to the venules and capillaries in this region. One can readily understand the development of fibrosis, pigmentation, and ulceration in these cases. The additional factors of trauma, infection, and sensitivity to fungus infestation are also involved in secondary roles.

Viewed from the vantage point of altered basic physiology rather than local manifestations in the leg and skin, several suggestions as to diagnosis and treatment become apparent. First, visualization of the deep venous tree by means of erect ascending and retrograde phlebography may be a real help in the differential diagnosis and selection of definitive treatment. Second, if evidence of reflux is present, measurement of venous pressures at the ankle and foot, on motionless standing and during ambulation, will confirm the clinical impressions.

Conservative treatment, indicated for lesser degrees of involvement, consists of elastic support, elevation of the feet at rest and at night, scrupulous foot hygiene and continuous control of epidermophytosis. Bland medicaments for ulcerations, together with this regime, may result in healing. The patient must constantly reckon with the physical factors of gravity and hydraulic pressure.

Patients who do not respond to conservatism, or those with advanced disease, may require some form of surgery. Superficial varicosities should be ligated or excised, provided adequate deep venous return is present. Some authorities recommend interruption of the

hydrostatic column in the deep veins by ligation. This may be effective in carefully selected cases. The popliteal vein is named as the site of choice; however, the lower portion of the superficial femoral is also used. Grafting for ulcerations is performed as indicated. Lumbar sympathectomy is useful for extremities with mild venous insufficiency and vasospasm.

Gratifying and successful results will follow the careful evaluation and selection of cases for treatment among these truly disabled patients.

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Atlanta, Georgia

BOOK REVIEWS

The Editors of THE AMERICAN SURGEON *will at all times welcome new books in the field of surgery and will acknowledge their receipt in these pages. The editors do not, however, agree to review all books that have been submitted without solicitation.*

EARLY CARE OF THE SERIOUSLY WOUNDED MAN. By HENRY K. BEECHER, M.D., Chief, Dept. Anes. Massachusetts General Hospital. Springfield, Illinois, Charles C Thomas, 32 pages.

This is publication No. 138 in the American Lectures in Surgery and concerns itself with the treatment of the seriously wounded patient from the moment of injury until such time as he can be repaired. It discusses in detail, and at some length, how important is the task of proper examination and preparation for surgery. He at first considers the whole category of the seriously wounded: resuscitation, immediate transfusion, splinting, use of morphine, etc. The care of specific wounds is next discussed rather briefly but adequately.

The next section of this monograph is devoted to the use of morphine or other narcotics and is followed by a section on anesthesia. The monograph down to this point is excellent. The section on anesthesia is for the most part very good but it is amusing how hard acceptance of new ideas is for some people. It has certainly been very conclusively shown by many good anesthesiologists that barbiturate anesthesius are safe in many procedures not limited to just a half hour in length, although I suppose it is well to sound a warning so that the inexperienced may not get into difficulty.

This would be an excellent booklet for all physicians included in the Civilian Defense program as well as those engaged in bilitary medicine. Thus it is a must for almost all physicians, for the general principles are most important. It should also be remembered that whether the injury be due to an atomic explosion or to an automobile wreck at the corner, the principles are the same.

A. H. LETTON, M.D.

SURGERY AND THE ENDOCRINE SYSTEM. By JAMES D. HARDY, M.D., F.A.C.S., Ass't. Prof. of Surgery, University of Tennessee Medical College. Philadelphia. W. B. Saunders Co. Illustrated, 1952. 152 pages, cloth binding.

This is one of the finest little monographs we have seen in modern literature on the care of the surgical patient. It is written in an easy style which is understandable and concise. The author has helped to clarify the ways in which certain recent advances in physiology affect the surgical patient.

At first he discusses the alarm reaction in the surgical patient, describing the role of the various hormones, then the metabolic aspects of body fluid regulation and of shock. These two chapters alone make the book a bargain for here are discussed the part which the endocrine organs play in mobilizing and transporting the metabolic reserves in any emergency. The activity of the endocrine organs of course affect the metabolic processes of the carbohydrates, fats, proteins, body fluids and antibodies. The role of the adrenal, thyroid and pituitary are discussed in particular.

He next discusses the physiologic aspects of nutrition which may affect the patient's ability to withstand trauma and considers the rationale of early ambu-

lation and consequences of prolonged bed rest. The effects of endocrinology on infection, tissue destruction and repair are discussed. Chapter 6, which concludes this portion of the book, concerns itself with the endocrine treatment of surgical patients.

The next half of the book considers surgery of the various endocrine systems.

This is a very fine book. Its contents should be familiar to every doctor who treats trauma whether accidental or surgical.

A. H. LETTON, M.D.

AN ATLAS OF GENERAL AFFECTIONS OF THE SKELETON. By SIR THOMAS FAIRBANK, D.S.O., O.B.E., M.S., Hon. M.Ch. (Orth.), F.R.C.S., Consulting Orthopaedic Surgeon and Emeritus Lecturer in Orthopaedic Surgery, King's College Hospital; Consulting Surgeon, Hospital for Sick Children; Emeritus Consulting Surgeon, Lord Mayor Treloar Orthopaedic Hospital; Honorary Consultant (Orthopaedic) to the Army. Baltimore, The Williams and Wilkins Co., 1951, 398 pages. $10.00.

Sir Thomas Fairbank has been for many years interested in affections of the skeleton. He has in the past written extensively on this subject and much of the subject matter in this text has been published in the British issue of the Journal of Bone and Joint Surgery.

This is a most fascinating book and will serve as a reference book for the common as well as the rare affections involving bone.

It is difficult to say with certainty which chapters are the most interesting but this reviewer particularly enjoyed the chapters devoted to Diaphysial Aclasis, Dychondroplasia, Fibroscystic Disease of Bone, Resistant Rickets, Infantile Cortical Hyperostosis, and Skeletal Metastases.

A total of eighty conditions and syndromes have been discussed in this Atlas. Some have been discussed in detail while others, because of their rarity, mentioned only briefly.

The orthopaedist, radiologist, pediatrician, and internist will find this a most helpful book. The reproductions of the illustrations and radiographs are of excellent quality and contribute to making this an unusually fine book. Every chapter has a complete index and it is printed on good paper.

WOOD W. LOVELL, M.D.

Books received are acknowledged in this section, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

GYNECOLOGIC AND OBSTETRIC PATHOLOGY WITH CLINICAL AND ENDOCRINE RELATIONS. By EMIL NOVAK, A.B., M.D., D.Sc. (Hon., Trinity College, Dublin; Tulane), F.A.C.S., F.R.C.O.G. (Hon.). 595 pages, 3rd Ed. Philadelphia and London, W. B. Saunders Company, 1952. $10.00.

OPERATIVE NEUROSURGERY WITH EMPHASIS ON PROCEDURES IN TRAUMA. By E. S. GUARDJIAN, M.D., Professor of Neurosurgery, Wayne University College of Medicine, Chief, University Neurosurgical Service, Grace Hospital, Detroit, Michigan, and J. E. WEBSTER, M.D., Assistant Professor of Surgery, Wayne University College of Medicine, University Neurosurgical Service, Grace Hospital, Detroit, Michigan. Baltimore, The Williams and Wilkins Company, 1952. $10.00.